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Great Lakes Water Quality Fourth Annual Report to the International Joint Commission 1975

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GREAT LAKES
WATER QUALITY BOARD

INTERNATIONAL JOINT COMMISSION

GREAT LAKES WATER QUALITY
1975 ANNUAL REPORT

GREAT LAKES WATER QUALITY

FOURTH ANNUAL REPORT TO THE INTERNATIONAL JOINT COMMISSION

GREAT LAKES
WATER QUALITY BOARD
JULY 1976

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INTERNATIONAL JOINT COMMISSION

GREAT LAKES WATER QUALITY BOARD

July 1976

International Joint Commission

Canada and United States

Gentlemen:

The International Great Lakes Water Quality Board, as a requirement of the Water Quality Agreement of 1972, is submitting the following Annual Report on Great Lakes Water Quality prepared by the Board.

Respectfully submitted,

J.P. Bruce

Chairman

Canadian Section

G.R. Alexander, Jr.

Chairman

United States Section

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INTRODUCTION

April 15, 1976 marked the beginning of the fifth year of the Great Lakes Water Quality Agreement and the year in which the Parties are to conduct a comprehensive review of its operation and effectiveness. This Fourth Annual Report of the Great Lakes Water Quality Board to the International Joint Commission together with its supporting Appendices provide much of the information required for this review.

The water quality objectives of the Agreement were reviewed, a detailed evaluation made of conditions and trends of water quality in Lake Ontario, and the findings of the Upper Lakes Reference Study were prepared for presentation to the Water Quality Board and the Commission. During the year the Governments formally responded to the Second Annual Report of the Commission and this has improved the dialogue between the Commission and the eleven governments. Investigations under the Pollution from Land Use Activities Reference Group continue and a separate progress report has been prepared.

The first Chapter of this Report provides a general assessment of water quality in the boundary waters with particular reference to the nearshore problem areas. The remedial programs in place, underway or required to improve water quality in the problem areas are also reviewed. In addition, a detailed assessment of Lake Ontario in terms of existing water quality conditions and an analysis of trends is presented.

The next three chapters review the status of the major remedial programs outlined in the Agreement. These include the construction of municipal wastewater treatment plants, measures to reduce phosphorus inputs to the lakes, and industrial waste treatment programs.

Chapters 5 and 6 deal with two very significant problems in the Great Lakes: toxic substances and radioactivity. Government programs to reduce their impact on uses of the Great Lakes, particularly on fish and wildlife are described. Similarly, Chapters 7, 8 and 9 review dredging, land use and shipping activities and efforts to minimize any adverse effects these may have on water quality.

The Board presents its view of a framework for implementing the Great Lakes Water Quality Agreement and improving its effectiveness in Chapter 10.

The final chapters of the Report discuss future strategies to cope with new or emerging problems, propose new or revised water quality objectives and present an International Great Lakes Surveillance Program to provide the basic information required to show progress in achieving the objectives. In the past, emphasis has been placed on the measures to correct water quality problems caused by readily controllable sources. However, the Board has begun to evaluate the adequacy of current water quality management planning programs as a means to supplement point source controls to achieve and maintain the water quality objectives.

Detailed data and information on all the topics discussed are included in Appendices A - D, the reports of the various subcommittees of the Board. These Appendices, although published as part of this Report, represent the independent efforts and views of the subcommittees, and consequently some of the subcommittee's views may not be reflected, in the Board's Report.

SUMMARY & CONCLUSIONS

Progress towards attainment of the goals established by the 1972 Agreement has been made but it is generally slow, uneven, and in certain cases disappointing.

In those cases where wastewater treatment has been up-graded there has been noticeable improvement in the water quality of affected nearshore areas. Municipal pollution abatement on the United States side has been hampered by the slow use of available funds. Phosphorus loadings to Lake Erie from major urban centers are three times greater than 1975 targets - Cladophora and other aquatic plants are still a problem in the lower lakes and may worsen unless programs for readily controllable sources are accelerated and solutions found for remaining sources. Waste controls at certain paper mills on the Canadian side of Lake Superior are inadequate and the discharge from Reserve Mining Company on the U.S. side continues.

New findings of toxic substances - particularly serious in Lake Ontario - point to the need for further attention and federal legislation on the United States side.

Steady progress was made in several programs and a number of important legislative measures were passed in both countries. In Canada, the federal Environmental Contaminants Act and the Ontario Environmental Assessment Act were passed. Intergovernmental agreements between Canada and Ontario pertinent to the Great Lakes were revised to strengthen administration and financing of programs. In the United States, legislation to limit or ban polychlorinated biphenyls (PCBs) was passed by the states of Indiana, Michigan, Minnesota and Wisconsin and federal legislation in the form of a Toxic Substances Control Act is still pending. PCB control in Canada will be addressed under existing provincial legislation and the new federal Environmental Contaminants Act.

The permanent obligation of the countries to maintain and enhance water quality of the Great Lakes requires early adoption and implementation of preventive measures, and effective surveillance programs. Coordination of planning and its implementation by governments is central to prevention of further pollution owing to continuing population growth, resource development and increasing use of water.

WATER QUALITY AND SURVEILLANCE

General improvements in water quality were observed in some local areas of Lake Ontario and parts of Lake Erie where remedial programs have been put in place. However, there are major municipal and industrial remedial programs still to be completed and it will be several years before significant improvements are likely to be observed in the open waters due to the long response time.

Problems having the greatest adverse effect on the recreational use of the lakes are offensive growths of the alga Cladophora and unacceptable bacterial levels at a number of public beaches.

The trophic status of the main body of Lake Ontario has not changed significantly since 1967 and may not improve over the next decade or so. A recent analysis of Lake Ontario suggests expected improvements in its trophic state may be limited by the effects of phosphorus inputs from land drainage and the atmosphere. Because these sources are difficult to control renewed emphasis must be placed on the effective operation of existing municipal phosphorus removal facilities, completion of all proposed facilities on a priority basis, extension of phosphorus control to all point sources in the Great Lakes system and on limiting the phosphorus content of detergents where this measure has not been adopted by state and federal governments.

Lake Erie continues to have excessive algal growths and depressed oxygen levels. The anoxic area which developed in the bottom waters of Lake Erie in 1975 was greatly reduced over conditions found in previous years. This situation is believed to be the result of unusually calm and warm meteorological conditions in the spring which allowed a larger hypolimnion to be formed. A much greater area of anoxia likely would have occurred in 1975 if the hypolimnion had been smaller. Therefore, the reduced situation is not being taken as a definite indication of improvement but will be watched carefully in future years.

Whole Lake Contaminant Problems

Extensive contamination by toxic substances has damaged the important commercial and sport fisheries of the Great Lakes. The chief concern for Lake Ontario is the bioaccumulation of toxic contaminants such as PCBs and Mirex (a pest control and flame retardant product) in fish and wildlife. Mercury contamination of fish is a problem in the western basin of Lake Erie. In lakes Huron, and Michigan PCBs in fish are a major concern. In Lake Superior, items of concern include accumulation of PCBs and mercury in fish and high concentrations of asbestiform fibres in the water.

Lake Ontario studies in 1975 revealed almost total reproductive failure of some herring gull colonies in contrast to the reported near normal reproductive success in other Great Lakes colonies. The eggs of the Lake Ontario gulls contain some of the highest organochlorine residue burdens reported in any biological system. The adult gulls were found to contain fifteen organochlorine compounds and fourteen polynuclear aromatic hydrocarbon compounds (e.g. PCBs and DDT and its metabolites) in their tissues. The concentrations of Mirex, recently recognized as a contaminant in Lake Ontario fish, approached concentrations of DDT.

Nearshore "Problem Areas"

There are 63 "problem areas" in the nearshore areas of the Great Lakes where one or more water quality objectives are not being met. Progress is slow in correcting pollution in these areas from municipal, industrial and land drainage sources, where such activities have their greatest measureable impact. These intensively used areas along the coasts of the lakes, are important for drinking water supplies, recreation, providing a habitat for fish as well as receive wastes and drainage from the land. Also, it is in these areas where the quantity and quality of data is often the poorest. They must be assessed regularly for the effects of pollutants, including harmful chemical substances and radioactivity, to determine progress in the correction of water quality problems.

The lack of an adequate nearshore surveillance program on the U.S. side has hampered complete identification of "problem areas". An improved surveillance program as outlined in Appendix B, is needed and deserves the full support of the governments in the United States.

MAJOR REMEDIAL PROGRAMS

The Agreement requires that by December 31, 1975, major remedial programs be completed or underway to abate pollution of the Great Lakes from municipal and industrial sources and reduce the inputs of phosphorus.

Municipal Waste Control

Further delays have occurred in major sewage treatment plant construction projects at Detroit, Cleveland and Duluth. The Board urges the responsible federal, state and local agencies to review current program efforts with a view to expediting completion of these projects and to ensure continued progress in other municipalities.

In the United States municipal pollution abatement programs and support funding gathered considerable momentum in 1975 and obligations by September 30, 1977 are expected to double to a total of $5 billion for Great Lakes projects. Most of the remaining construction grant funds are scheduled for the larger projects including Detroit, Cleveland and Duluth. Some smaller projects will not be funded under current

Administration proposals until FY 1978 since the Administration has not requested additional funding for this program in FY 1977. This is particularly serious in the states of Minnesota, Ohio and Wisconsin and may be a problem in other states where the construction grant program will come to a halt unless funding for FY 1977 is provided.

Disposal and utilization of the increasing amounts of sewage sludge resulting from improved levels of treatment and phosphorus removal at municipal sewage treatment plants remains one of the difficult problems facing plant operators.

Combined and Storm Sewer Overflows

Combined and storm sewer problems continue to be significant causes of water quality impairment in the "problem areas" identified in this report. Unfortunately, progress in developing corrective programs is not uniform. Considerable improvements are under construction or planned in certain Ontario communities, and in the United States some construction is underway as well as much planning and demonstration work. However, progress in the United States will be hampered by proposed Administration amendments to PL 92-500 which would result in a reduced level of federal assistance for the correction of combined sewer problems. Additional administrative requirements and a shift in the burden of funding to local governments will inevitably delay correction of this long-standing problem.

Phosphorus Control

The reductions in phosphorus loadings to Lake Ontario and Lake Erie anticipated in the Agreement are not likely to be met on schedule. New estimates of the response of Lake Ontario indicate the likelihood of delayed recovery of the lake in response to current scheduled phosphorus reductions and the growing recognition of the importance of non-point sources of phosphorus. Only marginal further reductions in phosphorus loadings from municipal and industrial sources are possible after achieving 1 mg/l P, while significant amounts are entering the lake from the atmosphere, lake sediments and land drainage. The Board considers attainment of the target of 1 mg P/l or less in municipal sewage effluents to be imperative. Further, Great Lakes states which have not already done so should reconsider limitations on phosphorus in detergents.

In addition, while efforts are being made to improve the use of lake effect models for predictive purposes, further aspects which deserve the early attention of governments include consideration of:

1) a complete ban on phosphates in detergents used in the Great Lakes basin

2) the full attainment of the 1.0 mg P/l for all facilities in the Great Lakes System and investigation of the feasibility and cost effectiveness of requiring further reductions from point-source discharges of phosphorus

3) identification of the specific sources of phosphorus loadings from the atmosphere and land drainage, and determination of their relative significance.

4) measures to control further increases in phosphorus loadings resulting from new uses of land including agriculture, urban and general industrial development.

These conclusions also underline the importance of continuing to improve the municipal phosphorus control program in the Lake Erie Basin especially at Detroit, the largest single source of municipal phosphorus in the Great Lakes System. Other communities in the Lower Lakes lacking effective phosphorus control measures currently include Cleveland, Ohio, and Buffalo, Syracuse, Niagara Falls and Tonawanda, N. Y. Hamilton, Ontario unexpectedly failed to meet the 1 mg/l limit for phosphorus during 1975 with its existing treatment facilities and the need for installation of phosphorus control facilities is now under consideration.

Industrial Waste Control

Considerable progress has been made in the control of industrial wastes in both countries. With very few exceptions, requirements for industrial waste treatment or control have been established for all plants in the Great Lakes System and program emphasis has shifted to monitoring, surveillance and enforcement. Industrial wastes data management systems have been developed and where necessary should be improved for the purpose of exchange of information between the Governments and the Commission. Industries have been identified as contributors to water quality "problem areas", and programs in these cases should be given priority attention.

TOXIC AND HAZARDOUS SUBSTANCES

Toxic and hazardous materials represent a major threat to water quality and the fishery of the Great Lakes. PCBs occur throughout the system in the Upper Lakes as well as the Lower Lakes and notably Lake Ontario where a large part of the population of salmonid species and American eel contain PCBs at levels above both the U.S. FDA guideline of 5 µg/g and Health and Welfare Canada's guideline of 2 µg/g for human consumption.

Once PCBs have entered the environment there is relatively little that can be done to remove them. Their persistence ensures that they will be a long term environmental problem and it should be noted that most organisms in the Great Lakes presently contain more PCBs than the objective of 0.1 µg/g proposed by the Board.

The United States Congress is considering a Toxic Substance Control Act and in Canada the Environmental Contaminants Act was passed in late 1975. Regulations developed under these Acts will provide control of the manufacture, use and disposal of substances deemed as danger to human health or the environment. The early adoption by the Parties of Annex 9, a list of hazardous polluting substances, is essential to the development of cooperative programs to control these.

RADIOACTIVITY

Problem areas have been identified in Lake Ontario and Lake Huron with radioactive substances resulting from uranium mining and refining and nuclear fuel reprocessing and power generation. The need for continuing surveillance in these areas is indicated. The Board is concerned with the potential impact on water quality of the growing nuclear power industry.

LAND USE

The Governments are participating with the Commission in developing a definitive report on pollution from land use. The authority for this work was contained in the reference to the Commission in the Agreement and is being undertaken by the Pollution from Land Use Activities Reference Group. The report of the Reference Group is expected in 1978.

The Governments recognized that progress was being made in controlling pollution from certain specific land use activities and identified the following: urban land use, pesticide use, animal wastes and fertilizer, transportation, forestry, mining, recreation, pollution from sediments, shoreline and river bank erosion, land filling, and solid and liquid waste disposal. The progress being made in remedial programs in these areas will be of particular significance as governments proceed to increase their efforts in planning and preventive strategies in anticipation of continuing population growth, resource development and the increasing use of water.

DREDGING

The report of the International Working Group on Dredging recommended site specific assessment of polluted dredge spoils. The Board was disappointed that the Working Group was unable to recommend universal criteria for designating polluted dredge spoils, rather than the site specific assessment which the Board considered unduly burdensome to regulatory agencies. However, if the standing committee, as recommended by the Working Group, is established under the IJC, as the Board recommends, the Board would encourage further examination of the two approaches by the standing committee.

SHIPPING ACTIVITIES

Progress has been made by the U.S. and Canadian Coast Guards to control and abate pollution from shipping activities by reducing the potential for marine accidents through formalizing traffic routes, and reviewing and improving navigational aids and the development and implementation of cooperative international programs for the detection, control and clean-up of spills of oil or other hazardous polluting substances. Since the signing of the Agreement in 1972, very little has been accomplished in further developing programs with respect to improved vessel design, construction and operation, control of shipboard wastes, improvements in navigational equipment and manning standards for Great Lakes vessels.

Both existing United States and proposed Canadian regulations to control pollution from vessel wastes, allow for either complete containment or the discharge of adequately treated sewage. The proposed Canadian federal regulations will apply only to commercial vessels while Ontario by agreement with the federal government, continues to require no discharge of sewage from pleasure craft. However, a significant incompatability in the regulations in each country has arisen from the granting by U.S. EPA under PL 92-500 Section 312(f)(3) of the requests by some Great Lakes States to prohibit discharge of sewage for both commercial and pleasure craft. Michigan has been granted such a request for all the Great Lakes waters within its jurisdiction and Wisconsin has been granted a similar request for Lake Michigan. Wisconsin has been denied its initial application for Lake Superior. Minnesota has been denied a similar petition for Lake Superior under Section 312 (f)(4). The effect of prohibiting discharges in major portions of the Great Lakes from commercial vessels will mean that incompatible regulation of shipping exists between the two countries.

The majority of the Board, as in the past, continues to support regulations that completely prohibit the discharge of sewage from all vessels on the Great Lakes.

FUTURE STRATEGIES

As remedial programs are being implemented in both countries to "repair past damage" to the lakes, the attention of governments is being focussed on measures to prevent further pollution of them owing to population growth, resource development, increasing use of water and the implications these factors hold for the use of land. The responsibility for planning future use of the Great Lakes-St. Lawrence Drainage System has been accepted by the eleven governments and new legislation and policy initiatives have been taken to get at some of the root causes of the many problems affecting the quality of the boundary waters.

The initial steps being taken in both countries include area-wide or regional development planning measures, implementation of water-related facilities plans and the gradual development of plans and assessments for more orderly use of the resources of drainage basins. It is now imperative that efforts to develop these plans be hastened to take full account of both countries' increasing use of water and the lands being drained by that water.

In order to provide a coordinated basis for assessing programs in achieving the water quality objectives, the Great Lakes Surveillance Plan has been developed in this report, as well as the proposal for refinement of the water quality objectives.

The concepts of non-degradation and enhancement contained in the water quality objectives of the Agreement should be reinforced and be used as explicit guides for planning and, where appropriate, be embodied in developmental planning policies, legislation, plans, or by-laws. That is, these measures must be translated into requirements for reduction of presently uncontrolled sources of phosphorus and other pollutants, resulting from existing and new uses of land for urban and industrial development, food production and related energy supplies.

The public has a right to be informed and participate where possible in the planning of communities consistent with the goal of preventing further pollution of the Great Lakes environment. While legislation in some cases provides opportunities for public access to information the procedures involved are often complex and other avenues may exist to increase the public's information, influence and participation in this area. These opportunities should be clearly identified and supported by governments.

RECOMMENDATIONS

The Great Lakes Water Quality Board recommends that:

1. WASTE TREATMENT

- as a matter of urgency, population centres with the greatest impact on water quality, initiate or complete construction and operate adequate wastewater treatment facilities with phosphorus removal, to the level of 1 mg P/l or less, as soon as possible.

  - for Lake Erie, extraordinary efforts should be applied to complete sewage treatment facilities at Cleveland and Detroit by 1980 and to achieve adequate phosphorus removal as soon as possible.

  - for Lake Ontario, communities scheduled to begin phosphorus removal by January 1976, particularly Metropolitan Toronto, Hamilton and Rochester, should assure operation at the recommended level. Acceleration of the programs at Niagara Falls, N.Y., Buffalo, Syracuse and other major centers where phosphorus removal is not operational is also recommended.

  - for the Upper Great Lakes, early completion of treatment facilities at Duluth, Minnesota and Thunder Bay, Ontario are required. Further, it is recommended that an effluent limitation of 1 mg/l of phosphorus be extended to all municipalities in the Upper Great Lakes System.

- clean-up programs in all "problem areas" involving controllable municipal and industrial waste discharges be given urgent priority to meet the schedules for each discharger identified in this report.

- adequate waste control programs be concluded by Abitibi Paper Company and Great Lakes Pulp and Paper at Thunder Bay and Polysar at Sarnia, Ontario where present controls on these significant waste discharges contributing to "problem areas" are incomplete.

2. DETERGENT PHOSPHORUS CONTROL

- those jurisdictions in the Great Lakes Basin not now having any limitation on the phosphorus content of detergents, namely Ohio, Pennsylvania and Wisconsin, consider the imposition of a ban on phosphorus in detergents, and further that

- those jurisdictions having partial limitations, namely Canada and Michigan, also consider banning phosphorus from detergents for use in the Great Lakes Basin, and further that

- pending such action by the respective states, the municipalities in the major metropolitan areas of Cleveland and Detroit in the Lake Erie Basin give immediate consideration to banning phosphorus in detergents for use in their jurisdictions.

- the Governments meet to consider the alternatives for the re-formulation of detergents to exclude phosphorus compounds.

3. TOXIC AND HAZARDOUS POLLUTING SUBSTANCES

- as a matter of high priority, source identification, monitoring and control programs for persistent chemicals, such as polychlorinated biphenyls (PCBs), Mirex, polynuclear aromatic hydrocarbons (PAHs) and mercury, which adversely affect human health, wildlife, fish and other aquatic life be intensified. To this end, Canada expedite implementation of its recently enacted Environmental Contaminants Act and similarly the United States as a matter of urgency enact the Administration's proposed Toxic Substances Control Legislation.

- all federal, state and provincial programs be accelerated to eliminate controllable discharges of mercury and other toxic substances where these continue to exist.

4. DREDGING

- a Standing Committee on Dredging, with functions as recommended by the International Dredging Working Group, be established under the International Joint Commission to facilitate close cooperation between dredging activities and other water quality activities in the Great Lakes.

5. SHIPPING ACTIVITIES

- in keeping with previous Board and Commission recommendations, Governments adopt compatible regulations for the control of vessel wastes. The majority of the Board continues to support regulations based on complete prohibition of the discharge of sewage.

- the programs, studies and other measures for the control and abatement of pollution from shipping activities, onshore and offshore facilities, vessel design, construction and operation including the discharge of harmful quantities of hazardous polluting substances required by Annexes 3, 4, 5 and 7 be brought under the full purview of the Commission and the Board. In addition, the Board urges the Commission to recommend to the Parties that they assign specific responsibilities and deadlines for completion of these joint activity obligations of the Parties required in the Agreement.

6. WATER QUALITY OBJECTIVES

- the new and revised specific water quality objectives recommended in this Report be submitted to the Parties for adoption in the Agreement. In the Report there are other new specific water quality objectives which the Board has under review and these should also be brought to the attention of Governments to consider the implications of their being recommended for adoption.

- either the Commission or the Parties hold public hearings on the recommended water quality objectives and that the proposed objective for radioactivity, developed by the Parties, be included.

7. MODELLING

- continued support be given to the development of "lake effect models" to provide guidance for eutrophication and other pollution control programs. Further, it is recommended that increased efforts be made to refine the estimates of phosphorus loadings from the atmosphere and land drainage, and determine the fraction available for biological growth.

8. PLANNING AFFECTING WATER QUALITY

- because policies for the economic, social and physical development in the Great Lakes Basin affect the water quality of the lakes, the governments specify measures and programs to ensure achievement of the Agreement's water quality objectives in the formulation of such policies and further that

- the eleven governments actively support remedial programs on pollution from land use, and further that

- governments accept the water quality objectives of the Agreement as explicit guides in planning by embodying the objectives in relevant planning policies, legislation, control programs and by-laws.

- implementation of planning to achieve the water quality objectives be based on full consideration of existing and new uses of land for urban and industrial development, food production and related energy requirements.

9. PUBLIC AWARENESS AND COMMUNICATIONS

- the governments strengthen public awareness of the Great Lakes Water Quality Agreement by undertaking specific public information programs.

- the dialogue between the Commission and the eleven governments be strengthened and utilized to develop support for correction of the problems occasioned by delays in the municipal and industrial clean-up, the need to address the complicated issues of land drainage and storm and combined sewer-discharges and the lack of adequate data from surveillance, nearshore and effluent monitoring.

10. FUNDING REQUIREMENTS

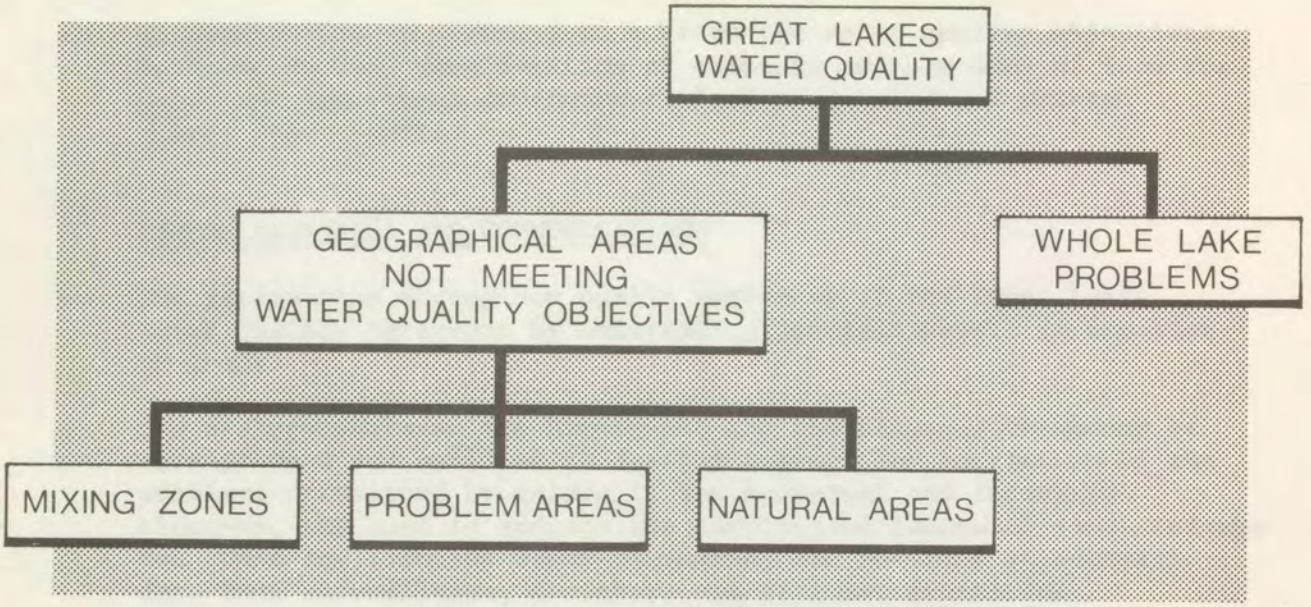
- the United States Government be requested to continue funding for municipal waste treatment plant construction grants under PL 92-500 at levels sufficient to ensure continued progress in providing the needed facilities.

- renewed attention be given by all governments to the provision of adequate funding, where this is presently lacking, for the identification and control of storm and combined sewer overflow problems.

- adequate funding be provided for the monitoring of municipal and industrial waste discharges, including radioactivity, by federal, state, provincial and municipal governments to assess the effectiveness of control programs.

- governments support and provide adequate funding for the International Great Lakes Surveillance Program described in this Report and its Appendix B. Special efforts are required to develop an adequate nearshore surveillance program on the United States side.

FIGURE 1. GUIDELINES FOR GREAT LAKES WATER QUALITY ASSESSMENT



EXPLANATION OF TERMS

MIXING ZONES - Restricted zones in the vicinity of point source wastewater discharges within which the specific water quality objectives shall not apply.

NATURAL AREAS - Areas that do not meet water quality objectives due to natural conditions.

PROBLEM AREAS - General geographical locations where water quality objectives and/or standards are not being met. The water quality in these locations can be improved through remedial measures.

Problem areas are further classified as:

a) Short Term Problems. Where the water quality parameters identified with the problem can be improved through short term abatement programs.

or

b) Long Term Problems. Where the parameters identified with the problem are expected to be improved through long term abatement programs. These are problems for which technological and/or legal remedial measures may not be currently available.

1 WATER QUALITY ASSESSMENT

The assessment of water quality in the Great Lakes continues to be based on information and data obtained from surveys, investigations and routine monitoring activities conducted by a large number of institutions for a variety of purposes. The lack of an internationally coordinated surveillance program, including adequate data quality assurance, means that the review is fragmented and that long term trends in water quality are difficult to develop.

The basic surveillance and monitoring data remain in the files of the various agencies or federal, state or provincial computer storage systems. Summary data reports and analyses, prepared by the various jurisdictions, provide the basis for the water assessment described in this chapter and detailed in Appendix B. All data summaries and original reports are available in the IJC Great Lakes Regional Office.

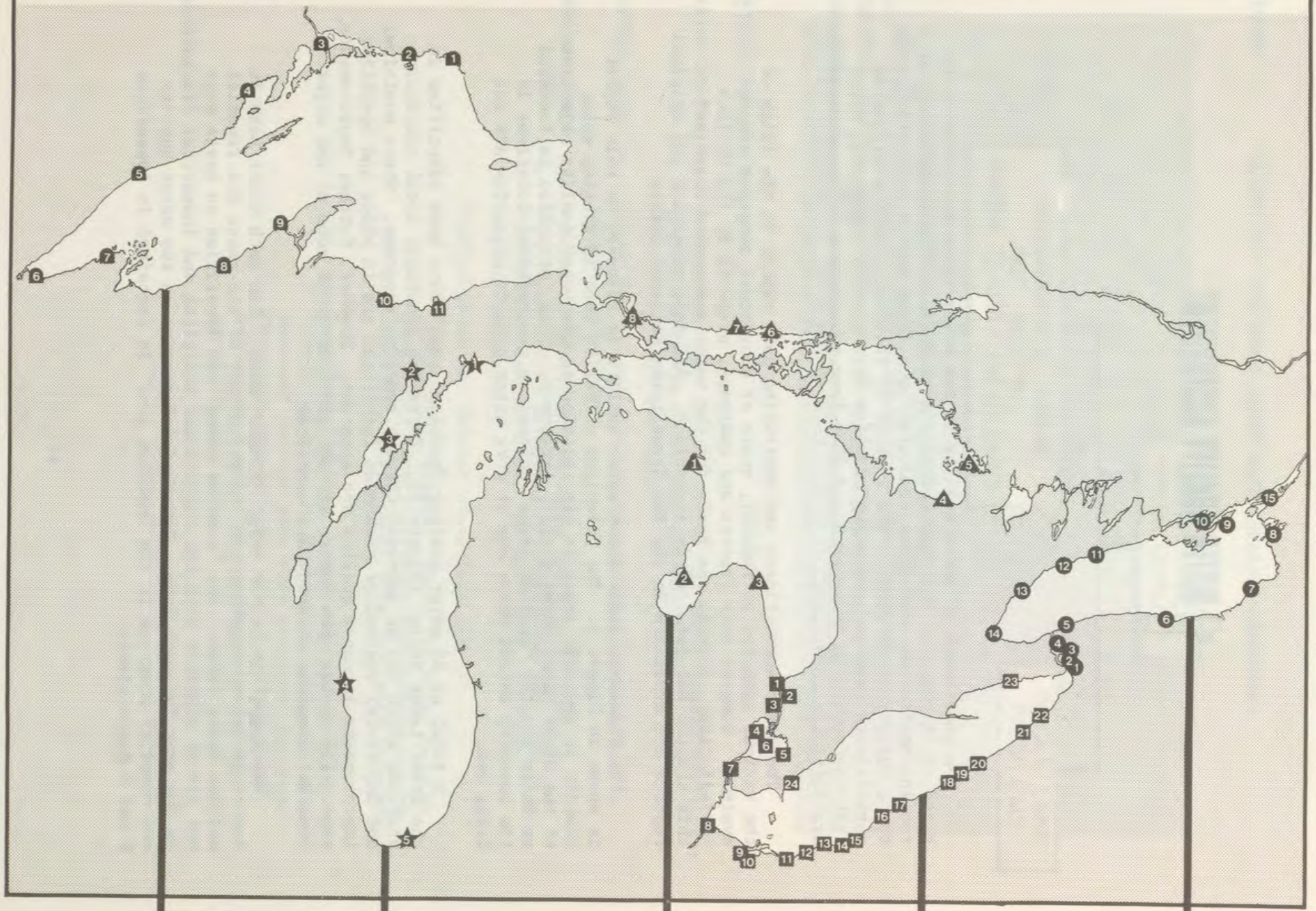
The framework under which water quality is assessed in this report is shown in Figure 1. The principal criterion used in gauging water quality in specific areas is its relation to the water quality objectives of the Great Lakes Water Quality Agreement. Thus, attention is focussed on water quality "problem areas" defined as geographical locations in the boundary waters where one or more water quality objective are not being met.

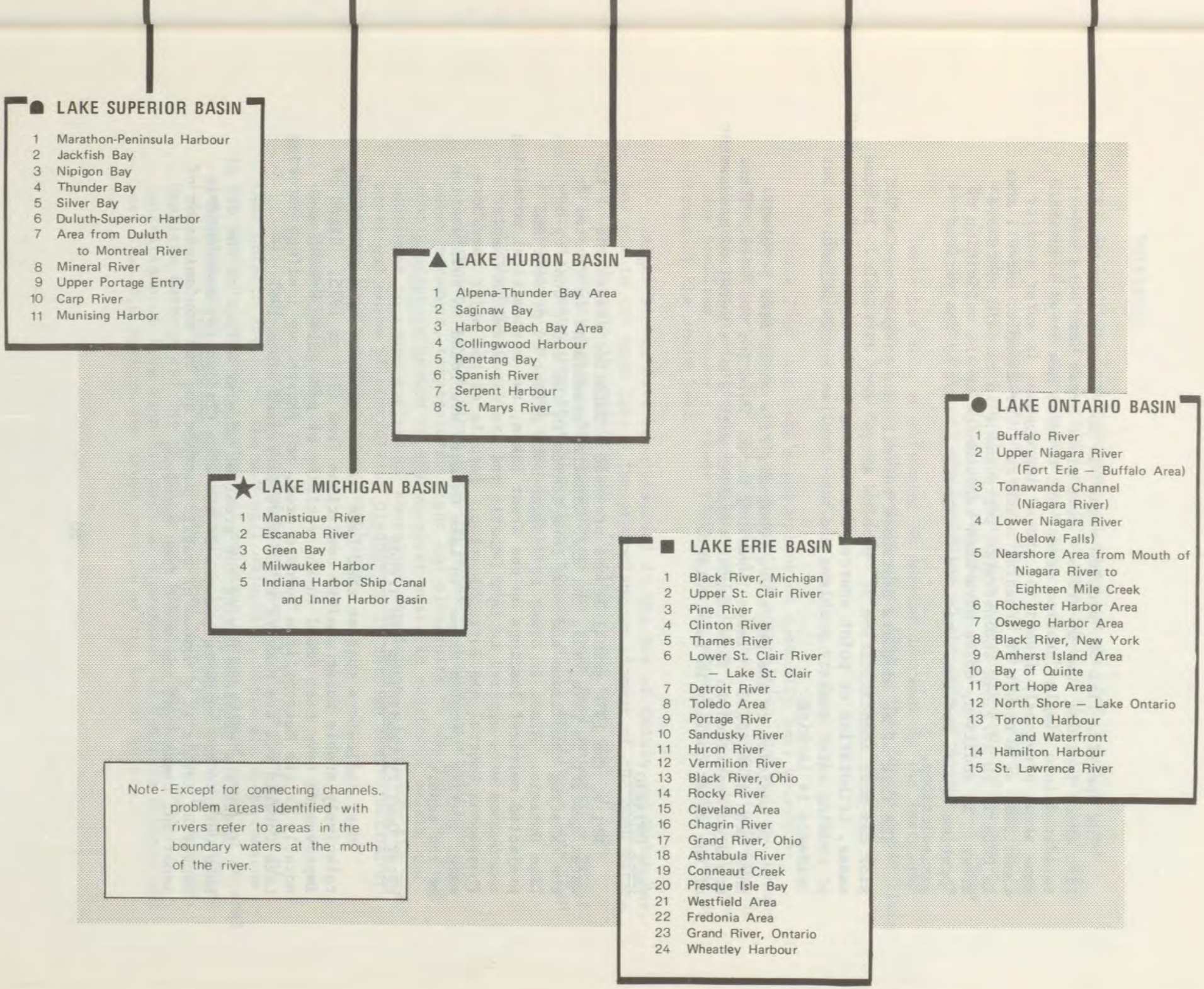
A total of 63 water quality "problem areas" have been identified in the Great Lakes Basin, (Figure 2). These are generally local nearshore problems which can be improved through remedial programs. Where municipal and industrial wastewater treatment facilities are in place and operating improvements in water quality are apparent. However, further improvements, especially in the open lakes, are not expected until some of the major remedial programs underway are completed.

Water quality in the major "problem areas" for each Great Lake is described below, together with an assessment of the cause and remedial actions being taken. The "problem areas" are identified on basin maps and listed together with the significant municipal and industrial dischargers in the area for each lake. Detailed information on the water quality and remedial programs in the "problem area" is contained in Appendices B and C respectively.

"PROBLEM AREAS" IN THE GREAT LAKES

Geographical locations in the boundary waters where one or more of the water quality objectives are not being met.




LAKE SUPERIOR BASIN
1 Marathon-Peninsula Harbour
2 Jackfish Bay
3 Nipigon Bay
4 Thunder Bay
5 Silver Bay
6 Duluth-Superior Harbor
7 Area from Duluth to Montreal River
8 Mineral River
9 Upper Portage Entry
10 Carp River
11 Munising Harbor
LAKE HURON BASIN
1 Alpena-Thunder Bay Area
2 Saginaw Bay
3 Harbor Beach Bay Area
4 Collingwood Harbour
5 Penetang Bay
6 Spanish River
7 Serpent Harbour
8 St. Marys River
LAKE MICHIGAN BASIN
1 Manistique River
2 Escanaba River
3 Green Bay
4 Milwaukee Harbor
5 Indiana Harbor Ship Canal and Inner Harbor Basin
LAKE ERIE BASIN
1 Black River, Michigan
2 Upper St. Clair River
3 Pine River
4 Clinton River
5 Thames River
6 Lower St. Clair River — Lake St. Clair
7 Detroit River
8 Toledo Area
9 Portage River
10 Sandusky River
11 Huron River
12 Vermilion River
13 Black River, Ohio
14 Rocky River
15 Cleveland Area
16 Chagrin River
17 Grand River, Ohio
18 Ashtabula River
19 Conneaut Creek
20 Presque Isle Bay
21 Westfield Area
22 Fredonia Area
23 Grand River, Ontario
24 Wheatley Harbour
LAKE ONTARIO BASIN
1 Buffalo River
2 Upper Niagara River (Fort Erie — Buffalo Area)
3 Tonawanda Channel (Niagara River)
4 Lower Niagara River (below Falls)
5 Nearshore Area from Mouth of Niagara River to Eighteen Mile Creek
6 Rochester Harbor Area
7 Oswego Harbor Area
8 Black River, New York
9 Amherst Island Area
10 Bay of Quinte
11 Port Hope Area
12 North Shore — Lake Ontario
13 Toronto Harbour and Waterfront
14 Hamilton Harbour
15 St. Lawrence River
Note - Except for connecting channels, problem areas identified with rivers refer to areas in the boundary waters at the mouth of the river.

The specific list of "problem areas" is not identical to the 1974 list which included some 69 areas. Some minor areas have been consolidated into single "problem areas" and several new areas identified. Some areas previously identified showed improvement in water quality conditions as a result of remedial measures. For example, surveillance in Ontario in 1975 has demonstrated improvement in certain nearshore areas. In addition, there have been refinements in the definition of "problem areas" and the basis for designating these by the various jurisdictions.

The lack of an adequate nearshore surveillance program on the U.S. side has made identification of "problem areas" very difficult. In some cases, tributaries or point sources discharging to the areas are "suspected" of causing water quality problems and non-compliance with objectives but evidence is lacking.

In addition to the nearshore problems, five whole lake problems have been identified in lakes Superior, Huron, Ontario, and Erie. These are also described in this chapter together with a more detailed assessment of the water quality in Lake Ontario.

LAKE ONTARIO

While, the 1974 Annual Report provided a detailed assessment of the water quality in Lake Erie, the 1975 detailed assessment is devoted to the existing conditions and long term trends in the water quality of Lake Ontario. Also, in order to evaluate the effect of present and projected nutrient loadings on the Great Lakes, two mathematical modelling approaches were applied to Lake Ontario and are discussed in Chapter 3 - Phosphorus Control and Eutrophication. Details of the major nearshore water quality "problem areas" in Lake Ontario are found in this section of the report.

Water Quality Conditions and Trends

Most indicators suggest that Lake Ontario experienced a period of relatively stable water quality conditions from 1967 to 1975. Signs of improvement have been found in the vicinity of some urban areas, most notably in the Metropolitan Toronto area, and phosphorus loadings entering Lake Ontario via the Niagara River have decreased since 1967.

Among the problems having the greatest adverse affect on the use of Lake Ontario are nuisance growths of the alga Cladophora, unacceptable bacterial levels at a number of public beaches and PCB contamination of important commercial and sport fish species.

Nutrients

In both the open lake and nearshore waters, total and soluble reactive phosphorus levels have been relatively stable since 1967 when compared for the same season each year.

Total phosphorus levels near urban centres are higher than in either the open lake or along relatively undeveloped shoreline areas. The Toronto area in 1975 showed the highest level, about 2 - 2.5 times that of the open lake, at the beginning of the growing season.

There has been an estimated 20 percent increase in the inorganic nitrogen content of open lake waters since 1968. This increase parallels that of nitrogen loadings to the lake.

Phytoplankton

Since 1968, the lake's phytoplankton community has, undergone increases in biomass, changes in species composition, and a trend toward more marked seasonality and instability. It has also shown increases in the occurrence of species associated with bloom conditions and taste and odor problems. However, these changes do not appear to be significant in terms of the whole lake.

Algal blooms have been observed in the Bay of Quinte and Sodus Bay, but not in the open lake. The phytoplankton biomass of the open waters of Lake Ontario is presently 10 - 20 times lower than that of Lake Erie's western basin. Measurements at the South Peel waterworks intake west of Toronto show that blue-green species still constitute less than 10 percent of the total algal biomass.

Cladophora

Nutrient levels along with the normally occurring conditions of water movement, temperature, light and alkalinity in the lake are such that Cladophora growth occurs wherever suitable substrate exists and continues to cause unpleasant shoreline conditions. Currently the most practical means of controlling Cladophora is through the reduction of nutrient inputs particularly phosphorus.

Dissolved Oxygen

Although, present dissolved oxygen levels in the open waters of Lake Ontario are above the 6.0 mg/l objective, there are some reasons for concern. In 1972, a study of sediment oxygen demand revealed several deepwater areas near the sediment-water interface with depressed oxygen levels. In addition, oxygen levels in two significant nearshore areas, Hamilton Harbour and Bay of Quinte are severely depleted. Concentrations of less than 1.0 mg/l were measured in Hamilton Harbour and less than 3.0 mg/l in the lower portion of the Bay of Quinte.

An important factor in maintaining adequate dissolved oxygen in the open waters is the depth of the hypolimnion. Since Lake Ontario is relatively deep, the large volume of water in the hypolimnion when the lake stratifies provides sufficient dissolved oxygen to satisfy the oxygen demanding processes without significant depletion.

A long term trend for dissolved oxygen in Lake Ontario is difficult to establish. No severe oxygen depletion problems have been identified in the open waters of the lake, and minimum dissolved oxygen levels between 70 and 80% saturation have been observed over the last 10 years.

Dissolved Solids

The dissolved solids objective of 200 mg/l is exceeded throughout the lake. It could not be reasonably achieved without substantial reductions in inputs to the Lake Erie Basin. There have been some reductions in loadings and the concentration of dissolved solids in the lake has stabilized since 1970 - 71 in response to the greater flow-through with the high water levels. The concentration can be expected to continue to rise and fall with the water levels.

Microbiology

Counts of coliform bacteria, which indicate the possible presence of pathogenic organisms, have been improving along many north shore beaches since 1972. Only two locations in the Toronto area are failing to meet the Agreement objectives. On the U.S. side, beaches near Rochester continue to be affected by sewage and stormwater overflows.

Open waters have been found to be generally free of any fecal contamination. Heterotrophic bacteria found in the open waters indicate that nutrient loadings from the Niagara River, Metropolitan Toronto and Rochester areas have a widespread effect on the lake.

Fish Contaminants

Lake Ontario supports a diverse fish community of over 112 species and their contamination by PCBs and mercury is of serious concern. Further discussion of toxic substances in fish is included in Chapter 5.

Sampling of salmonid species and American eel has revealed that virtually the entire population contains PCBs at levels above the Canadian Department of National Health and Welfare guidelines of 2 µg/g for human consumption. No information on trends for this contaminant exists.

The State of New York has found mercury levels in some bass species to exceed the 0.5 µg/g limit set by the U.S. FDA as fit for human consumption.

Residues of total DDT have been decreasing and all species are reportedly now meeting the 5 µg/g guideline set by U.S. FDA.

Problem Areas

As a result of the consolidation of 8 minor areas and the division of the Niagara River into 2 distinct areas, the number of "problem areas" reported in the Lake Ontario basin has been reduced to 15 as compared to 20 in 1974.

These problem areas together with the significant municipal and industrial dischargers are listed in Table 1 and located in Figure 3. Significant locations in Canada are Hamilton Harbour, Toronto Central Waterfront, Port Hope and the Bay of Quinte; and in the United States, Oswego Harbor, the Rochester area, the Niagara River and the International Section of the St. Lawrence River.

Hamilton Harbour

In Hamilton Harbour, during the summer months, a dissolved oxygen problem exists in the hypolimnetic waters when the average oxygen concentration falls to approximately 2 mg/l. Areas in the deep portion of the harbour, near the Hamilton Sewage Treatment Plant, along the industrial shore and at the western end develop the largest oxygen deficits.

The bacteriological water quality in the harbour is generally poor with severe bacterial contamination being confined to the south-eastern section of the harbour where both the total and fecal coliform objectives were exceeded in 1975. Only the total coliform objective was exceeded elsewhere in the harbour during the same period.

Iron concentrations in the harbour waters are generally above the 0.3 mg/l Agreement objective. Highest levels were reported near the steel mills where the 1975 annual mean in the surface waters was 0.47 mg/l iron.

The harbour is eutrophic and experiences algal blooms in the summer. In 1975, the average chlorophyll a concentration was 17 µg/l in the surface waters with a maximum of 43 µg/l recorded in July at the north end of the harbour. High phosphorus levels which (averaged 80 µg/l in 1975) are probably responsible for the observed algal blooms. 1975 data indicate that the Hamilton Municipal Sewage Treatment Plant effluent contains 2.0 mg P/l without chemical treatment. Phosphorus removal facilities have been provided by Dofasco and the town of Dundas.

Sediments in the harbour have elevated levels of heavy metals. Both lead and mercury are present in greater concentrations than those the Ministry of the Environment considers acceptable for open water disposal of dredged materials.


Kingston
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Oshawa
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Toronto
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LAKE ONTARIO
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Oswego
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Hamilton
Rochester
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Fig. 3

TABLE 1

LAKE ONTARIO "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref.	"Problem Areas"	Significant Dischargers
1	Buffalo River	Allied Chemical (Buffalo Dye Plant and Industrial Chemical Division), Mobil Oil, Donner Hanna Coke Corporation and Republic Steel.
2	Upper Niagara River (Fort Erie-Buffalo Area)	Buffalo STP.
3	Tonawanda Channel (Niagara River)	North Tonawanda STP; Allied Chemical, Ashland Oil, Hooker Chemical (2 Plants), Union Carbide, E.I. DuPont (2 Plants), Carborundum Corp., Spaulding Fibre and International Paper.
4	Lower Niagara River (below Falls)	Niagara Falls and Lewiston STPs; Stauffer Chemical.
5	Nearshore Area from Mouth of Niagara River to Eighteen Mile Creek	
6	Rochester Harbor Area	Northwest Quadrant, Rochester, Frank Van Lare), Gates-Chili-Ogden and Webster STPs.
7	Oswego Harbor Area	Oswego STP.
8	Black River, New York	Watertown STP.
9	Amherst Island Area	
10	Bay of Quinte	Belleville and Trenton STPs.
11	Port Hope Area	Eldorado Nuclear.
12	North Shore - Lake Ontario	
13	Toronto Harbour and Waterfront	
14	Hamilton Harbour	Hamilton and Dundas STPs; Dofasco, Stelco.
15	St. Lawrence	Diamond International Corp., and Aluminum Co. of America.

STP - Sewage Treatment Plant

The benthic fauna of the harbour are characterized by low species diversity and high densities, with tubificid worms being dominant. Toxic conditions, characterized by an absence of invertebrates exist in the southeast corner of the bay near the Hamilton Sewage Treatment Plant outfall.

Concentrations of PCBs in carp, white bass and gizzard shad caught in Hamilton Harbour were above the tolerance level of 2 µg/g set by Health and Welfare Canada.

The high phosphorus, coliform, and iron concentrations and the low dissolved oxygen levels observed in Hamilton Harbour, result from years of past abuse of the waters of Burlington Bay. This situation is being gradually corrected and future reports should show the effects of improved sewage treatment, phosphorus removal and industrial waste controls. Phosphorus controls became operational at year end in Burlington and Dundas. The effluent of the plant serving Hamilton was expected to meet the criteria for phosphorus without supplementary chemical treatment.

Toronto Central Waterfront

Water quality in the Toronto Inner Harbour has improved in recent years, becoming less eutrophic. The bacterial contamination in the nearshore zones of the harbour, however, remains a cause for concern.

The nearshore bacteriological water quality of Toronto Inner Harbour is poor in its northern sector adjacent to storm and combined sewer outfalls. The total and fecal coliform criteria were exceeded along the Bayfront and Port areas through most of 1975. The south shore of the Inner Harbour, situated away from major input sources, rarely exceeded this criteria in the same time period. Strong seasonal differences in total coliform densities, are to be expected with highest levels recorded in the summer and fall.

Although phytoplankton blooms still occur in the harbour, their severity has been decreasing in recent years. Chlorophyll a has fallen from an average of 21 µg/l recorded in 1969 - 70 to 11.7 µg/l in 1975. The trend of decreasing chlorophyll a levels in the harbour parallels a decrease in total phosphorus levels in the harbour and in the Don River. This reduction can be attributed to the reduction of phosphorus in detergents and in part, to the effect of high lake levels in 1972 - 1975.

Nutrient levels in the sediments of the Inner Harbour are high. Both phosphorus and volatile solids levels exceed Ministry guidelines for open water disposal of dredged material. Highest levels were recorded at the mouth of the Don River in the Keating Channel.

The high coliform counts found along the Toronto Central waterfront in the inner harbour and in the vicinity of the Humber River reflect discharges from combined sewer overflows. Water quality in the harbour has become less trophic in recent years, however, bacterial contamination in the nearshore waters of the harbour remain a concern. Construction of the mid-city interceptor sewer has been completed and will be in operation by September 1976. It is expected that overflows to Lake Ontario will be reduced and water quality improved. Details of the programs are contained in the stormwater and combined sewer discussion in Chapter 2 - Municipal Pollution Abatement.

The benthic community in the harbour is chiefly composed of pollution tolerant oligochaete worms. Highest densities of oligochaetes were found in the Keating Channel and in the northwest section of the harbour adjacent to an industrial complex. A decrease in tubificid worm densities recorded in recent years parallels an improvement of water quality in the harbour during the same time period.

Fish caught in the harbour are considered to be unfit for human consumption due to high PCB and DDT levels.

Port Hope Area

Values of ^{226}Ra in excess of the Ontario permissible criterion of 3 pCi/l were encountered in surface water samples at 4 stations inside Port Hope Harbour. At one station in Lake Ontario just offshore from the Port Granby waste disposal site, samples taken in September and October, 1975 showed levels similar to the public surface water criterion. Periodic samples of the Port Hope water supply show levels of ^{226}Ra to be less than 1 pCi/l and within the Ontario drinking water criterion.

A general discussion of radioactivity in the Great Lakes is contained in Chapter 6.

Bay of Quinte

The Bay of Quinte is in an advanced state of eutrophication. Poor water quality adversely affects recreational use of the Bay and reduces its suitability as a source of water supply. The recreational and commercial fisheries, which were once among the most productive in Ontario, have declined drastically.

Dissolved oxygen levels near the bottom approach zero during calm weather conditons because of thermal stratification in the shallow upper bay.

Bacterial levels exceed the objectives during the summer near the communities of Trenton, Belleville, Deseronto and Picton.

Rochester

The bathing beaches on Lake Ontario near the mouth of the Genessee River remain closed because of bacterial contamination. In addition the lake waters in this area continue to be degraded due to erosion, urban runoff and combined, storm and sanitary sewer overflows. U.S. EPA has Demonstration Programs underway to establish the magnitude of the problem and identify cost-effective solutions.

Oswego Harbor

Water quality in Oswego Harbor ranges from poor to fair because of the direct discharge of raw and inadequately treated wastes. Secondary treatment and phosphorus removal facilities are under construction for the west side of the City of Oswego to complement the recently completed facilities for the east side. Upstream discharges, both point and non-point sources, also contribute to pollutant loadings in the Oswego River and the Oswego Harbor area.

Niagara River

Although the Niagara River serves as a receiving body for a multitude of municipal and industrial waste discharges, no violations of the dissolved oxygen standards have been reported in the mainstream. Correspondingly, the BOD, total phosphorus and total coliform levels remain generally low, with the exception of local areas along the New York shoreline as shown in the following selected examples.

The Black Rock Canal experiences periods of low dissolved oxygen (3 mg/1), high coliform levels (30,000/100 ml median) and relatively high phosphorus levels. Along the New York shoreline of the main stream of the river, near Buffalo, the coliform objective is exceeded within 30 - 90 m (100 - 300 ft) from shore. Upstream of Niagara Falls, the coliform objective is also exceeded 300 m (1000 ft.) from the U.S. shore. The phenol objective in the upper river frequently exceeds the IJC objective. However, near Buffalo, there has been a moderate reduction in phenol concentrations with monthly sampling results for 1967 - 1970 ranging from 1 - 36 µg/1 and a mean of 8 µg/1, compared to the 1970 - 1975 data which ranged from 1 - 31 µg/1 with a mean of 2 µg/1.

All of the municipal plants discharging to the Niagara River with the exception of Niagara Falls, New York, had primary treatment and disinfection prior to 1967. Niagara Falls, while providing chlorination, simply screens its wastewater to remove gross solids and will continue to discharge essentially raw sewage until a secondary treatment plant with phosphorus removal is completed, probably by early 1977.

All of the municipalities discharging directly to the Niagara River as well as the larger communities on the tributaries are, or will be providing, phosphorus removal facilities. The 1971 - 72 ban on detergent phosphates appears to have reduced mean levels of phosphate in municipal sewage treatment plant effluent by approximately 50 percent.

Most of the remedial facilities undertaken by industries are scheduled for completion by July 1, 1977.

St. Lawrence River

Except for isolated areas near the major population centres, water quality in the St. Lawrence River is good and has not deteriorated substantially since 1968. PCB levels in fish and elevated phosphorus concentrations are the result of carry-over from the upstream Great Lakes Basin.

In the Ogdensburg area, treatment facilities for Diamond International Corporation are under construction. Secondary treatment and phosphorus removal for the City of Ogdensburg are to be completed in 1978, with construction to start in 1976.

The Aluminum Company of America in Massena, New York is in the final stages of converting to a dry processing operation. Compliance with effluent limitations is expected by July 1977.

The Ontario industries along the River show little effect of waste discharges beyond the zone of initial mixing and are not considered to contribute to problem areas along the St. Lawrence River.

LAKE ERIE

In the Lake Erie Basin a total of 24 "problem areas" have been identified, (Table 2 and Figure 4). The most significant problems are the Detroit River, nearshore areas at Toledo, Cleveland Harbor area and the open waters of the lake. The remaining areas are generally located at the mouths of tributaries to the lake.

Detroit River

There has been a major effort to control water pollution along the Detroit River during the last ten years. Great improvements have been made, particularly in reducing oil and steel mill pickle liquor entering the river. However, the near-shore areas still have water quality problems which persist because of the intense industrial and commercial activity along the shore, the major municipal sewage treatment plants, and combined sewer overflows.

Comparison of 1975 water quality with that of previous years shows a significant improvement in pH and dissolved oxygen and the water quality objectives for these parameters are now being met. Problems with high coliform bacteria and iron concentrations still remain. A new analytical procedure for phenol which gives improved sensitivity to low concentrations was adopted in early 1975. As a result, phenol was detected throughout the river.


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Sarnia
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Detroit
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Windsor
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24
LAKE ERIE
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Toledo
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Cleveland
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Erie
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Buffalo

Fig.4

TABLE 2

LAKE ERIE "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref.	"Problem Areas"	Significant Dischargers
1	Black River, Michigan	
2	Upper St. Clair River	Imperial Oil, Polysar, Dow Chemical.
3	Pine River	
4	Clinton River	
5	Thames River	
6	Lower St. Clair River - Lake St. Clair	
7	Detroit River	Detroit and Wayne County-Wyandotte STPs. Town of Belle River; Allied Chemical, Monsanto, McLouth Steel, Great Lakes Steel, Pennwalt, BASF Wyandotte and Firestone.
8	Toledo Area (Maumee River)	Toledo, and Lucas Co., STPs; Gulf Oil Refinery, Interlake Steel, Standard Oil and Campbell Soup.
9	Portage River	Oak Harbor STP.
10	Sandusky River	Fremont STP.
11	Huron River	Huron STP.
12	Vermilion River	Vermilion STP.
13	Black River, Ohio	Elyria and Lorain STPs; United States Steel.
14	Rocky River	Lakewood, Berea, North Olmstead, and Strongsville STPs.
15	Cleveland Area	Akron, Cleveland, (3 Plants), Euclid, Ravenna, Solon and Kent STPs; Republic Steel, U.S. Steel, Jones & Laughlin Steel, Harshaw Chemicals, E.I. DuPont, Firestone, Cleveland Electric and Ford Motor Co.

(Continued)

TABLE 2 (Cont'd)
LAKE ERIE "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref.	"Problem Areas"	Significant Dischargers
16	Chagrin River	
17	Grand River, Ohio	Painesville and Fairport Harbor STPs; Glyco Chemicals, Uniroyal Chemicals and Diamond Shamrock.
18	Ashtabula River	Ashtabula STP; RMI Sodium Chloride Plant, Sobin Chemicals, Union Carbide and Olin Corp.
19	Conneaut Creek	
20	Presque Isle Bay	
21	Westfield Area	Westfield STP; Growers Co-op.
22	Fredonia Area	Fredonia and Dunkirk STPs.
23	Grand River, Ontario	
24	Wheatley Harbour	Omstead Foods.

STP - Sewage Treatment Plant

Significant pollutant loadings are transported to Lake Erie by the Detroit River its largest tributary. Chloride loadings have decreased more than 20% since 1968. The total phosphorus load has decreased by more than 60% since 1968, although 1975 river measurements showed a slight increase over 1974. Remedial measures currently underway should further reduce the total phosphorus loading. The only parameter which has shown a definite upward trend in recent years is nitrate, which has more than doubled since 1968.

The largest municipal sewage treatment plant in the area -- indeed, the largest single source of treated wastewater in the Great Lakes Basin --is the City of Detroit Plant. This plant serves more than 3 million people. Upgrading the Detroit Wastewater Treatment Plant by providing secondary treatment and phosphorus removal is currently underway. Construction has been completed on facilities necessary to achieve secondary treatment for approximately 2.3×10^6 cubic metres per day (m^3/day) (600 million gallons per day (MGD) and secondary treatment capacity for $4.0 \times 10^6 m^3$/day (1050 MGD) will be available in 1980. Significant reductions in the phosphorus and phenol loadings will result as these facilities are completed and fully utilized.

Construction of the Wayne County-Wyandotte Wastewater Treatment Plant has recently been completed with the addition of secondary treatment and phosphorus removal for an average flow of $3.8 \times 10^5 m^3$/day (100 MGD). Start-up procedures commenced in the spring of 1976 and full operation is expected sometime during the summer of 1976. These facilities will also significantly reduce the discharges of phosphorus and phenol to the Detroit River.

Approximately eighty combined sewer overflows exist along the Rouge and Detroit Rivers and contribute to the high concentration of coliform organisms, phosphorus, ammonia, and chlorides found in the river. The city of Detroit operates an extensive monitoring and remote control network on the combined sewer system to utilize available storage capacity in the system to the maximum extent possible and reduce the amount of first flush overflows. Additional studies on the combined sewer overflow problem have been initiated and within the next two years this information, coupled with the regional planning underway, should provide detailed data on the extent of the problem and suggested remedial actions.

High concentrations of chlorides are attributed to stormwater runoff from the Metropolitan area and industrial dischargers. BASF Wyandotte and Pennwalt, the major industrial dischargers, are expected to achieve NPDES permit requirements for chlorides by 1977.

Great Lakes Steel (Blast Furnace Division), BASF Wyandotte, Pennwalt, McLouth Steel and Monsanto are expected to be in compliance with NPDES permit requirements for ammonia by 1977.

There is a problem with fish tainting resulting from the presence of dissolved organics in the area. Significant dischargers are Imperial Oil Enterprises Limited, Polysar Limited, and Dow Chemical of Canada Limited.

Toledo Area

At the mouth of the Maumee River water quality problems of low dissolved oxygen, high fecal coliform counts and high phosphorus concentrations are present. The Toledo sewage treatment plant with a flow of $3.2 \times 10^5 m^3$/day (85 MGD) is providing secondary treatment and phosphorus removal. Effluent phosphorus concentrations in 1975 averaged 2.5 mg/l, much higher than the Agreement target level of 1 mg/l.

Cleveland Harbor

Water quality in Cleveland Harbor is degraded by the Cuyahoga River. Measurements in the river indicate problems of low dissolved oxygen, high concentrations of ammonia, dissolved solids, zinc, copper, phenols and cyanide and elevated temperatures.

Numerous municipal and industrial sources contribute to this problem area. The last eleven miles of the Cuyahoga, from the Cleveland Southerly Sewage Treatment Plant to the mouth, are polluted to such a degree that general water quality standards cannot be attained with the implementation of the best practicable treatment levels by all dischargers.

Major sources of the BOD in this area are probably the Akron Sewage Treatment Plant and Brandywine Creek, the latter having numerous sanitary discharges and one industry discharging large amounts of BOD substances.

Downstream from the Cleveland Southerly Sewage Treatment Plant discharge, during critical low flow periods, the Cuyahoga River remains in violation of the dissolved oxygen, ammonia and dissolved solids water quality standards of Ohio EPA. The problems encountered in this area are caused by the numerous sanitary sewer overflows, industrial dischargers, and the Cleveland Southerly Sewage Treatment Plant effluent. The total pollutant loadings discharged to this last segment of the Cuyahoga River are much too high for the river to assimilate and the flow characteristics of this area magnify the problem. As the river approaches Lake Erie its velocity is reduced, creating an extensive settling basin which must be dredged frequently to maintain a proper depth in the navigation channel.

Apparently, it is not economically feasible for these larger dischargers to attain best available treatment levels. Due to these circumstances, less stringent water quality standards have been adopted by Ohio EPA for the lower Cuyahoga River. For example, the allowable concentration for ammonia has been raised from 1.5 mg/l to 12 mg/l until June 30, 1976. From July 1, 1976 to January 1, 1979, ammonia levels are to be less than 8 mg/l. The dissolved oxygen standard also has been relaxed.

Nearshore Areas

Tributaries such as the Black, Sandusky, Grand and Ashtabula rivers in Ohio have been identified as major sources of inputs of fecal coliforms, phosphorus, metals, suspended and dissolved solids, oil and grease etc. The extent of their impact on the lakes is not known as there is no nearshore surveillance program in these areas.

Open Waters of Lake Erie

In the western basin, increases were apparent in both chlorophyll *a* and total phosphorus concentrations. However, phytoplankton biomass measured at Union (Kingsville) water intake on the Ontario shoreline of the basin has shown a continued decreasing trend since 1967. The increases observed in total phosphorus in the western and central basin are believed due to increased resuspension of sediments and increased loading from the Detroit River.

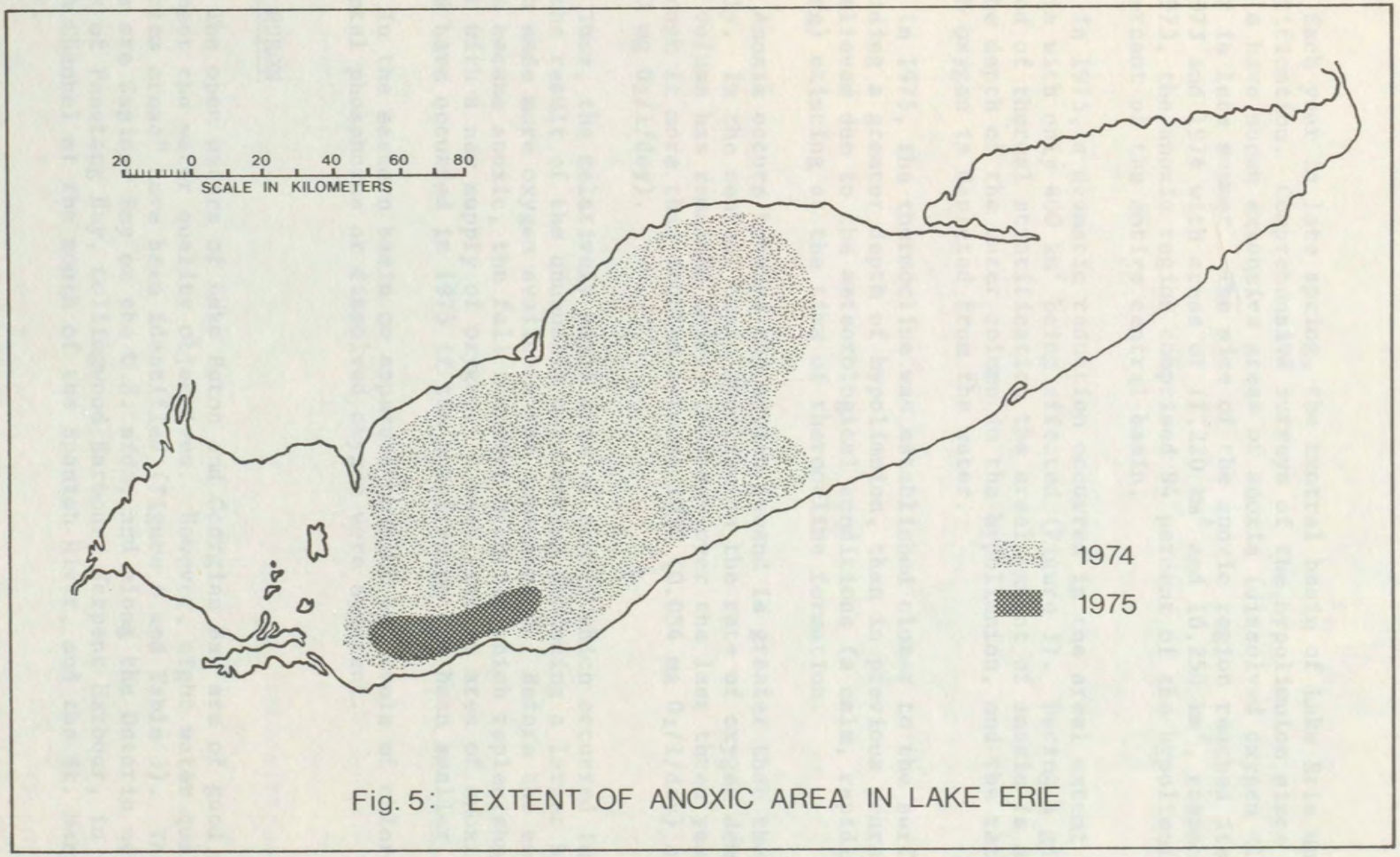

Fig. 5: EXTENT OF ANOXIC AREA IN LAKE ERIE

Each year in late spring, the central basin of Lake Erie undergoes thermal stratification. Comprehensive surveys of the hypolimnion since the late 1950's have shown extensive areas of anoxia (dissolved oxygen <1 mg/l) occur in late summer. The size of the anoxic region reached its maximum in 1973 and 1974 with areas of 11,220 km^2 and 10,250 km^2, respectively. In 1973, the anoxic region comprised 94 percent of the hypolimnion and 70 percent of the entire central basin.

In 1975, a dramatic reduction occurred in the areal extent of the anoxia with only 400 km^2 being affected (Figure 3). During a given period of thermal stratification the areal extent of anoxia is a function of the depth of the water column in the hypolimnion, and the rate at which oxygen is depleted from the water.

In 1975, the thermocline was established closer to the surface, providing a greater depth of hypolimnion, than in previous years. This is believed due to the meteorological conditions (a calm, rapidly warming spring) existing at the time of thermocline formation.

Anoxia occurs because the oxygen demand is greater than the available supply. In the central basin hypolimnion the rate of oxygen demand per unit volume has remained fairly constant over the last three years, although it more than doubled between 1930 (0.054 mg O_2/1/day) and 1970 (0.13 mg O_2/1/day).

Thus, the relatively small area of anoxia which occurred in 1975 was the result of the unusually warm spring producing a larger hypolimnion which made more oxygen available for consumption. Before the entire basin became anoxic, the fall turnover occurred which replenished the water with a new supply of oxygen. A much greater area of anoxia likely would have occurred in 1975 if the hypolimnion had been smaller.

In the eastern basin no apparent changes in levels of chlorophyll a, total phosphorus or dissolved oxygen were apparent.

LAKE HURON

The open waters of Lake Huron and Georgian Bay are of good quality and meet the water quality objectives. However, eight water quality "problem areas" have been identified (Figure 6 and Table 3). The prinicipal areas are Saginaw Bay on the U.S. side, and along the Ontario nearshore areas of Penetang Bay, Collingwood Harbour, Serpent Harbour, in the North Channel at the mouth of the Spanish River, and the St. Marys River.

Problems in Saginaw Bay include enrichment from excessive nutrients resulting in high phytoplankton levels, presence of PCBs and other organic compounds in fish, polluted sediments, and taste and odor in water supplies.


Sault
Ste. Marie
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GEORGIAN
BAY
Midland
LAKE HURON
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4
Owen Sound
Penatanguishene
2
3
Bay City

Fig. 6

The major municipal dischargers contributing to these problems include Saginaw, Bay City, Zilwaukee, Essexville and Midland which are in compliance with NPDES discharge permit requirements and are currently providing 80 percent phosphorus removal. In addition, combined sewer overflows contribute significantly to the water quality problems. Construction is underway in Saginaw to add a combined sewer overflow retention basin and another basin is scheduled for construction in 1976. Bay City has commenced a program to separate approximately 1/3 of its existing combined sewer system and construct three retention basins. Additional construction phases are planned to separate the balance of the combined sewers and install retention basins as necessary.

Construction of secondary treatment and phosphorus removal facilities should be completed at Genessee County-Montrose by July 1976. Facilities

TABLE 3

LAKE HURON "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref. △	"Problem Areas"	Significant Dischargers
1	Alpena-Thunder Bay Area	Abitibi Paper.
2	Saginaw Bay	Saginaw, Bay City, Zilwaukee, Essexville, Midland, Genessee County and Flint STPs; Dow Chemical and General Motors.
3	Harbor Beach Bay Area	Hercules Corp., and Searle Laboratory.
4	Collingwood Harbour	Collingwood STP.
5	Penetang Bay	Penetanguishene STP.
6	Spanish River	Eddy Forest Products.
7	Serpent Harbour	Denison Mines and Rio Algom Mines.
8	St. Marys River	Sault Ste. Marie, Ontario STP; Algoma Steel, Abitibi Paper.

STP - Sewage Treatment Plant

under construction at the City of Flint will provide tertiary treatment and phosphorus removal by March 1977. Completion of these facilities will reduce phosphorus loadings to the Bay by an estimated 1360 kg/day.

The significant dischargers of dissolved solids and chlorides, Dow Chemical in Midland and Michigan Chemical Company in St. Louis, are scheduled to be in compliance with NPDES discharge permit requirements by January 1977.

In Ontario, phosphorus levels and resulting Cladophora growths have been cited as problems in Penetang Bay due to discharges from the Town of Penetanguishene's overloaded wastewater treatment plant. Plant expansion and reinstitution of phosphorus removal is scheduled for completion by March 1976. However, reduction of algal biomass within the Bay is expected to occur slowly because of the limited mixing and flushing of the Bay waters.

Local enrichment of Collingwood Harbour is directly influenced by loadings from the town's municipal pollution control plant, harbour flushing rate, street runoff and available nutrients from resuspended sediments. The situation is compounded considerably by the shape and orientation of the harbour. Reductions of algal growths as a result of phosphorus removal are expected to be achieved slowly. Past problems which plagued the construction and ultimate startup of the phosphorus removal facilities at the Collingwood Water Pollution Control Plant have been overcome. However, the domestic waste strengths being treated may require the provision of secondary sewage treatment.

In the North Channel, near Spanish River, upstream waste discharges to the Spanish River from Eddy Forest Products pulp and paper mill at Espanola have contributed excessive quantities of phenols at the river mouth resulting in tainting of fish caught for sport and commercial purposes. Completion of the first stage of conversion of the mill process and waste treatment system by 1977 should result in reduction of BOD loadings, color, phenol, toxicity and fish tainting.

Low levels of radium are found in Serpent Harbour, although inputs from uranium mining activities upstream on the Serpent River have been diminishing steadily since 1966. This is attributed to a natural decrease in river flow over the period and the completion of barium chloride treatment of decanted tailings and mine drainage. In 1976, treatment facilities will be installed at the Denison-Stanrock property and all active and idle mining properties in the drainage system will then be receiving treatment for removal of radium and heavy metals.

In the St. Marys River continued violations of the phenol and microbiology objectives and Ontario Ministry of the Environment drinking water criterion for cyanide were found in 1975, although, some improvements were noted. Phenol levels were significantly reduced due to a change in the type of coal used in making coke at Algoma Steel. The concentrations of cyanide averaged 0.28 mg/l (criterion 0.2 mg/l) for a distance of 0.3 km downstream fromthe Algoma outfall, but do not threaten any existing municipal water supplies.

Cyanide, ammonia, phenols and oil are discharged by Algoma Steel Corporation into the St. Marys River at Sault Ste. Marie, Ontario. An Order was issued to Algoma to provide treatment for the coke mill effluents, bar and strop mill wastes, coke oven by-products and coke quenching waste discharges. Compliance with this Order is required by December 31, 1976.

Recent expansion of the Sault Ste. Marie, Ontario sewage treatment plant from 3.6 to 5.4 x $10^4 m^3$/day (8 to 12 MGD Imp.) has resulted in improved effluent characteristics. A consulting engineer will be asked to examine further improvements in sewage collection and treatment and the development of a new treatment facility to serve the northwest section of the city.

At the Abitibi Paper Company process sewer separation and waste treatment are to be completed in July 1976. Suspended solids are to be reduced to 6900 kg/day.

LAKE MICHIGAN

The open waters are of generally high quality with only minor occurrences of degraded water which fails to meet the objectives for the international waters of the Great Lakes. Five problem areas have been identified in Lake Michigan (Table 4 and Figure 7).

Green Bay has been cited as a problem area by Wisconsin. The monthly average of dissolved oxygen at the mouth of the Fox River in August 1975 was 2.78 mg/1, the minimum daily average was 0.76 mg/1, and the minimum hourly value was zero. Total phosphorus limits occasionally exceed the 1.0 mg/1 limit in spite of the new phosphorus removal facilities. The 5 µg/g level for PCB concentration prescribed by the U.S FDA was exceeded in carp and white fish. Modelling indicates that 1977 levels of Best Practicable Treatment (BPT) for municipal and industrial dischargers BPT will result in meeting the D.O. standards in Green Bay but not in the Fox River. Best Available Treatment (BAT) has not yet been defined for all categories of industries. Michigan has also classified Green Bay as a problem due to taste and odor in water supplies.

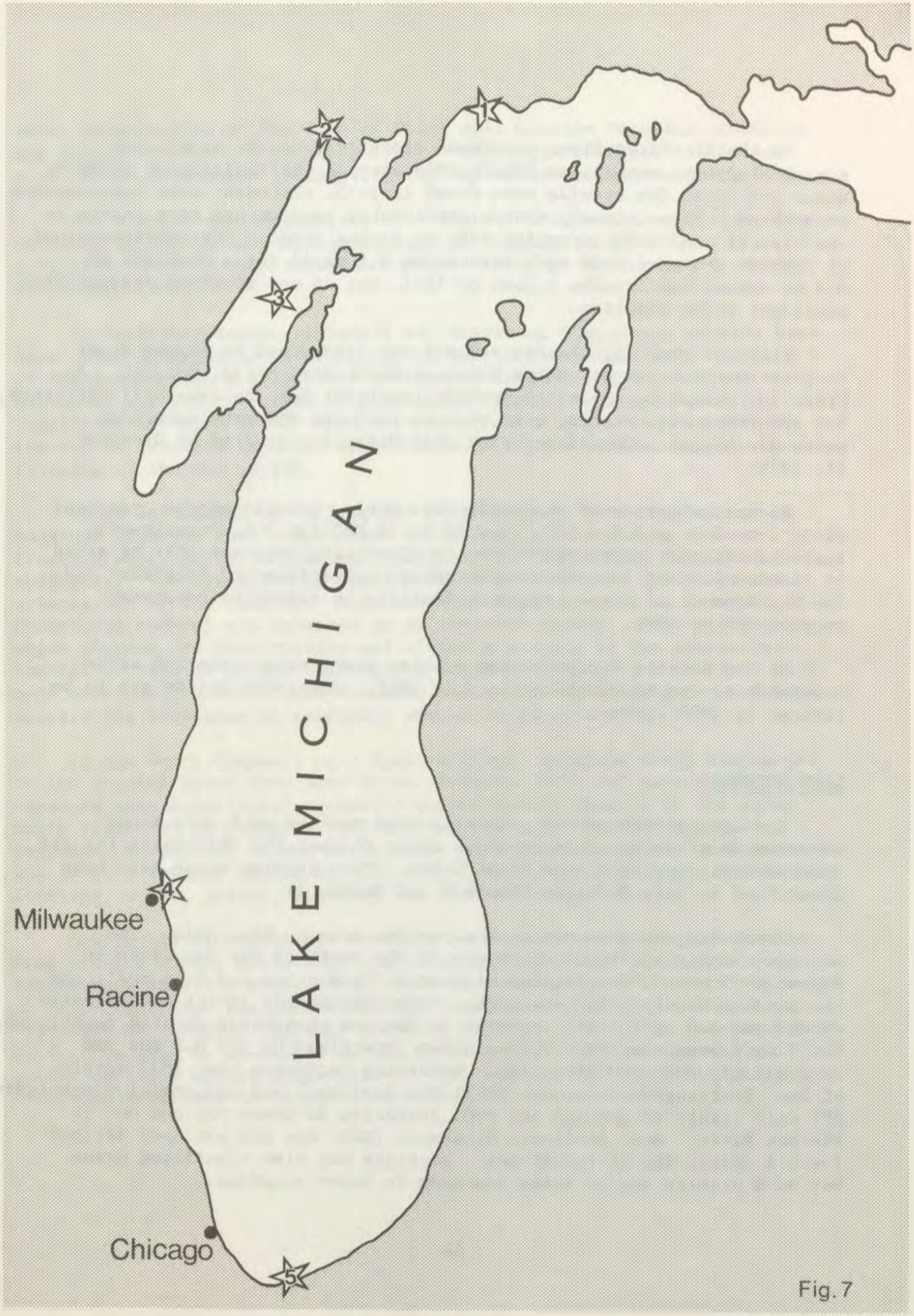

Fig. 7

Improvements in waste treatment with marked reductions in discharge loadings to the Fox River are being made. In 1975, the Green Bay Metropolitan Sewerage District placed additional facilities into operation to provide a higher level of treatment and to handle the wastes from the American Can and Charmin Paper mills in the city. These facilities are expected to result in a 45,000 kg/day BOD reduction for 1976 compared to the 1975 tabulated loadings. Industries on the lower Fox River providing their own waste treatment are expected to meet the 1977 deadline. Although, the final allowed loadings, after adjudication, may be greater than presently required in the proposed permits, they will represent substantial reductions in existing loadings.

TABLE 4

LAKE MICHIGAN "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref. ☆	"Problem Areas"	Significant Dischargers
1	Manistique River	Manistique STP.
2	Escanaba River	Escanaba STP.
3	Green Bay	Menominee, Escanaba, Gladstone and Green Bay STPs; Mead Corp., Bergstrom Paper Co., Fort Howard Paper Co., Consolidated Paper, Green Bay Packaging, Hammermill Paper, Nicolet Paper, John Strange Co., George Whiting Paper, Neenah Paper, Badger Globe, Kimberley Paper, Appleton Paper, American Can Co., and Charmin Paper.
4	Milwaukee Harbor	
5	Indiana Harbor Ship Canal and Inner Harbor Basin	East Chicago, Gary and Hammond STPs; Atlantic Richfield, E.I. DuPont, Inland Steel, Union Carbide, United States Steel and Youngstown Sheet and Tube.

STP - Sewage Treatment Plant

LAKE SUPERIOR

The quality of the open waters of Lake Superior is generally better than the prescribed water quality objectives stated in the Agreement. However, eleven problem areas have been identified (Table 5 and Figure 8), of which five: Duluth-Superior Harbor, Silver Bay, Western Lake Superior, Nipigon Bay, and Thunder Bay are considered to be major.

Water quality violations for several parameters were detected in samples taken in the Duluth-Superior Harbor in 1975:

Dissolved oxygen concentrations did not comply with Minnesota's standard of 6 mg/l in 13% of the samples.

Fecal coliform standard of 200 MPN/100 ml was violated in 27% of the samples.

Phenol exceeded the 10 µg/l standard in 41% of the samples.

Copper exceeded the 10 µg/l standard in 20% of the samples.

Nutrients in the harbor were also above the levels which stimulate the growth of algal blooms.

The fecal coliform counts are largely the result of discharges from the Potlatch Corporation, Conwed Corporation, and the Cloquet and Duluth Main wastewater treatment plants. The phenol levels in St. Louis Bay are partially the result of discharges from Conwed Corporation, U.S. Steel and Potlatch Corporation. Resuspension of decomposing river sludge deposits downstream from these discharges may also be contributing to the problem. The copper levels are largely the result of natural runoff in the Nemadji River watershed tributary to St. Louis Bay. Chlorination is provided at the municipal waste treatment plants and they are generally in compliance with the 200 MPN/100 ml effluent limitations. Limited data from compliance monitoring surveys on Conwed and Potlatch Corporations indicate that these companies are discharging a large number of fecal coliforms. All dischargers listed above, except for U.S. Steel are scheduled to be incorporated into the Western Lake Superior Sanitary District's new wastewater treatment plant to be located on St. Louis Bay, and scheduled to be completed in mid-1978. Legal action for violation of Minnesota standards has been taken against U.S. Steel and an NPDES permit has not yet been issued to them.

The discharge of taconite tailings from Reserve Mining Company directly affects Silver Bay and has a general effect over much of Lake Superior. Tailings reduce water clarity 25% or more over at least 1500 km^2. Microscopic amphibole asbestos fibres have been detected throughout western Lake Superior with 87 million fibres per litre detected in the Duluth area and 250 million amphibole fibres per litre in Beaver Bay's drinking water.

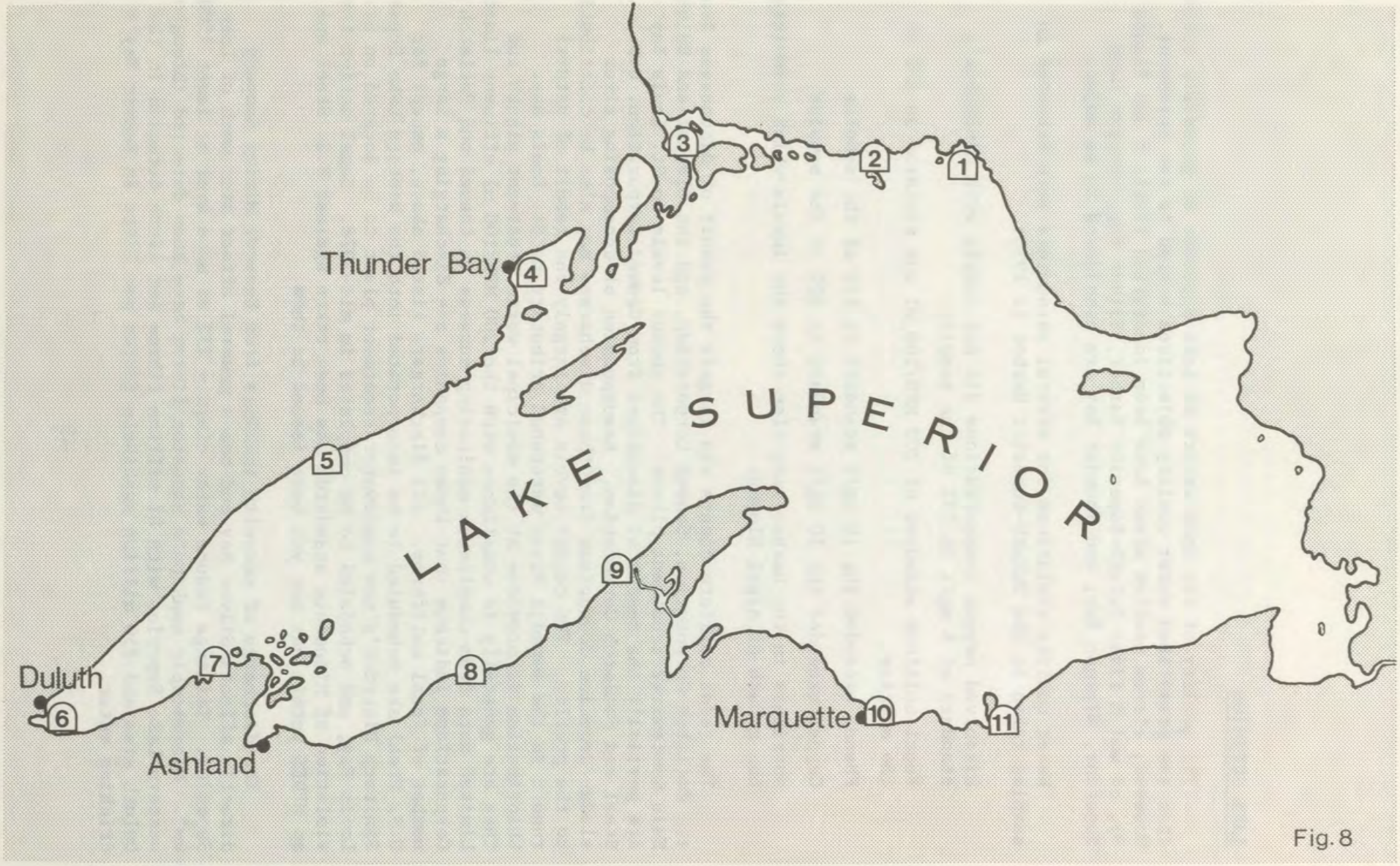
LAKE SUPERIOR
Thunder Bay
Duluth
Ashland
Marquette
1
2
3
4
5
6
7
8
9
10
11

Fig. 8

TABLE 5

LAKE SUPERIOR "PROBLEM AREAS"
AND SIGNIFICANT MUNICIPAL AND INDUSTRIAL DISCHARGERS

Map Ref.	"Problem Areas"	Significant Dischargers
1	Marathon-Peninsula Harbour	American Can.
2	Jackfish Bay	Kimberly Clark.
3	Nipigon Bay	Domtar Packaging.
4	Thunder Bay	Thunder Bay STP; Great Lakes Paper, Abitibi Paper, Canada Malting and Industrial Grain Products.
5	Silver Bay	Reserve Mining.
6	Duluth-Superior Harbor	Duluth, Cloquet and Superior STPs; Conwed Corp., United States Steel, Potlatch Corp., and Superior Fibre Products.
7	Area from Duluth to Montreal River	
8	Mineral River	White Pine Co.
9	Upper Portage Entry	
10	Carp River	Marquette STP.
11	Munising Harbor	

STP - Sewage Treatment Plant

Having concluded that "the pollution of Lake Superior must cease as quickly as possible", the U.S. Court of Appeals has required Reserve Mining to take prompt steps to abate its discharges. Toward this end, public hearings were conducted by Minnesota on the environmental impact of alternate on-land disposal sites. However, even after on-land disposal, the possible adverse health effects of asbestiform fibres in the municipal drinking water of many north shore communities will necessitate either treatment for removal or the selection of alternate sources of water supply.

In Nipigon Bay, Ontario bioassays have provided additional detail on effluent toxicity from the Domtar Packaging Limited's Red Rock Mill as reported in the 1974 Report. These analyses indicate lethal toxicity to phytoplankton and benthic organisms in a 0.25km^2 area adjacent to the outfall. However, the studies indicate no toxic effect to fish beyond the zone of initial mixing. Fish tainting studies showed that the potential for direct tainting of flesh did not extend beyong a 1 km radius of the outfall. To overcome the fish tainting and toxicity problems the Domtar Packaging Limited plant at Red Rock installed condensate stripping and other in-plant controls which became operational early in 1975.

In the Thunder Bay area, violations of microbiology and dissolved oxygen objectives occurred and high mercury levels persist in large lake trout. The construction of a new 1.1 x $10^5 m^3$/day (24 MGD Imp.) wastewater treatment plant to serve the City of Thunder Bay is well underway. In addition, major trunk and interceptor sewer construction is also progressing rapidly and all projects, now in various stages of completion, will be completed by March 1977. When this sewer program is completed, essentially all of the Thunder Bay area will be serviced by sanitary sewers.

Wastes from Industrial Grain Products Limited and Canada Malting Co. Ltd. contributed to elevated coliform levels in the harbour. However, both industrial sources will be connected to municipal sewers by 1977. Industrial wastes from these plants and those of the Abitibi Paper Company also contribute to oxygen depletion. At the north end of the harbour, near the Abitibi Paper Company, oxygen is depleted below 6 mg/l in an area of the inner harbour covering 1.50 km^2. The paper company is considering consolidation of its three Thunder Bay mills. The chlor-alkali plant of Dow Chemical of Canada Limited responsible for the mercury contaminated sediments was closed in 1973 and gradual dissipation of the effects of these deposits is expected.

SUMMARY

In essentially all of the problem areas identified remedial programs for the major point sources are underway. However, mid-1977 seems to be the earliest date contemplated for completion of most of these projects, and in fact some of the major municipal and industrial projects in the Detroit and Cleveland areas will not be completed until after 1980.

Allowing for some slippage in the completion dates and a year for changes to be reflected in water quality, significant improvements will probably not be documented until the 1979 Annual Report.

The lack of an adequate nearshore surveillance program on the U.S. side creates difficulties in properly identifying "problem areas" on a consistent basis and demonstrating improvement or continued degradation in these portions of the boundary waters. The adoption and implementation of a coordinated surveillance program to rectify this problem is recommended.

2 MUNICIPAL POLLUTION ABATEMENT

One of the most significant aspects of the Great Lakes Water Quality Agreement was the Governments' commitment that programs and measures for the control of pollution from municipal sources would be implemented.

Both Parties have substantially met the requirement under Article V to have municipal sewage treatment programs either completed or in the process of implementation by December 31, 1975. This is recognized as one of the first major achievements toward restoration of water quality. Early completion of construction now underway and effective operation and maintenance of all facilities are now recognized as primary imperatives of this program. By December 31, 1981, it is expected that all the sewered population in the Great Lakes System will be provided with adequate treatment.

Determination of the extent of pollution from storm sewers and combined water sewer overflows and the development and implementation of remedial programs is still underway and presents a major challenge for the future.

MUNICIPAL WASTEWATER TREATMENT

In the *United States* projects completed during 1975 increased to 59 percent the portion of 1971 sewered population receiving adequate sewage treatment (Table 6). Completion of projects now underway will bring the population served with adequate sewage treatment to 92 percent.

In *Canada,* sewage treatment projects completed in the Basin during 1975 increased the portion of the population served by adequate treatment to 94 percent of the estimated 1971 sewered population. A number of new projects involving modifications to existing facilities were begun and will be completed by 1977. By then the population served with adequate treatment will increase by 300,000, to almost 100 percent of the sewered population in the Ontario portion of the basin.

Expenditures and Funding

The funds available and committed to the construction of municipal wastewater treatment in both countries since 1971 are shown in Table 7. The increased rate of funding in the United States, particularly in 1975, reflects the uniform national requirements for secondary treatment under the PL 92-500 and the release of impounded funds. In Canada

TABLE 6

SEWERED POPULATION IN THE GREAT LAKES BASIN SERVED BY MUNICIPAL PROGRAMS COMPLETED OR IN THE PROCESS OF IMPLEMENTATION AS OF DECEMBER 31, 1975

	Number* of Municipal Facilities	Sewered Population** Total	Served by Adequate*** Treatment No. (%)	Served by Adequate*** Treatment Under Construction	Estimated Date for Achieving 100% Completion
United States	247	15.4	9.1 (59)	5.1	1981
Canada	89	4.8	4.5 (94)	0.3	1977
Total	336	20.2	13.6 (67)	5.4	

* Includes all facilities with design flows greater than 3.8 X 10^3 m^3/day (1.0 MGD)

** Sewered Population Estimates as of 1971 given in millions

*** The definition of adequate treatment differs between Canada and the United States

Note: Total Basin Population 27.4 million (1970), excludes Illinois.

TABLE 7

ANNUAL FUNDS (NON-CUMULATIVE) COMMITTED FOR SEWAGE CONSTRUCTION IN THE GREAT LAKES BASIN

(Millions of Current Dollars)

Year	Capital Commitments for Sewage Works in Ontario by all Levels of Government*	Obligated State and Federal Funds in the United States**
1971	57	370
1972	66	313
1973	138	419
1974	103	509
1975	112	950

* For Canada, figures represent total capital commitments for treatment plants and trunks. Major expenditures prior to 1971 are not shown.

** Figures represent total U.S. eligible project costs for sewage treatment with Federal grant approval (includes local, state and federal funds).

secondary treatment is not a uniform requirement, although ninety percent of the sewered population is served by this level of treatment in order to meet water quality objectives.

All Great Lakes states are continuing to obligate construction grant funds from their allocations under the initial $18 billion national program provided by PL 92-500. The additional funds scheduled to be committed to Great Lakes projects in the United States by September 30, 1977, the expiration date of current construction grant allocations under PL 92-500, will nearly double the total financial commitment to approximately $5 billion (Table 7). These additional funds are, for the most part, scheduled for the larger staged-construction projects such as Detroit and Cleveland. An estimated $62 million in additional funds will be necessary to insure completion of the required secondary treatment and phosphorus removal facilities for plants larger than 3.8×10^3 cubic metres per day (m^3/day) or one million gallons per day (MGD). Needs for Facilities with design flows less than 3.8×10^3 m^3/day are not included in the above estimate.

Some states will have fully obligated all of their construction grant funds through FY 76, and since additional appropriations are not proposed by the Administration until FY 1978, the construction grants program in Minnesota, Ohio, Wisconsin and possibly other Great Lakes states, will essentially come to a halt. Although no specific projects in the Great Lakes Basin have been identified as being affected by this hiatus in funding, the Board considers this to be a most undesirable situation because of the potential adverse effects on construction schedules and long range planning, and recommends that FY 77 funds be provided to correct this situation. It should be noted that both Houses of the U.S. Congress have under consideration Bills to provide FY 77 funding for this program.

The Board notes that the ultimate goal of this huge construction program is to provide adequate treatment for all of the sewered population, an achievement which will not be realized in a number of areas in the U.S. until 1981. In view of the long completion time and the slippages that have already occurred, especially for major projects like Detroit and Cleveland (Table 8), the Board believes that the responsible levels of government, (federal, state and local), should renew their efforts to expedite completion of these projects.

During 1975, Ontario negotiated an agreement with Central Mortgage and Housing Corporation to fund sewage treatment and storm sewerage projects through 1980. About $400 million are designated for Great Lakes projects for 1976 and 1977.

TABLE 8

STATUS OF MAJOR UNCOMPLETED MUNICIPAL PROJECTS

Facility	Sewered Population	Anticipated Completion Dates		Current Project Costs (Millions of Dollars)	
		As Stated in 1974 Report	Current Estimate	As Stated in 1974 Report	Current Estimate
United States					
Detroit, Michigan	3,129,000	1979 (phased construction)	After 1980	121.4	475
Duluth, Minnesota (Western Lake Superior Santitary District)	126,000	1977	Mid-1978	84.5	105
Gary, Indiana	175,400	1977		34.0	34
Cleveland, Ohio (Westerly)	250,000	1979	1980	90.0	90
(Easterly)	700,000	expansion planned		10.0	13
(Southerly)	635,000	1981	1981	180.0	200
Euclid, Ohio	71,550	1977	1978	12.0	12
Niagara Falls, N.Y.	102,400	1976	1976	63.0	63
Tonawanda, Y.Y. (Sanitary District No. 2)	107,700	1978	1978	62.0	65
Syracuse Metro, N.Y.	287,600	1979	1979	108.0	108
Buffalo, N.Y.	750,000	1978-79	1979	158.0	170
Canada					
Thunder Bay	106,000	1977	1977	10.7	11

Major Municipal Projects

The 1974 Water Quality Board Report identified project delays in ten major municipalities in the United States and one in Canada as shown in Table 8. The table also shows the sewered population to be served by each project, and the completion date and project costs as estimated in 1974 and 1975. The following discussion highlights the status of individual projects. Further details can be found in Appendix C.

Detroit, Michigan

The Detroit metropolitan wastewater collection and treatment system serves more than 3 million people in seventy-five suburban communities and the City of Detroit. The present flow averages 3.5 x 10^6 m^3/day (930 MGD). The largest single source of waste water in the Great Lakes Basin, Detroit, constitutes about one-half the total wastewater volume collected for treatment in the State of Michigan.

Construction of a pure oxygen activated sludge system was completed in 1974 with treatment for 1.1 X 10^6 m^3/day (300 MGD) begun in the second quarter of 1975. A conventional aeration system for 5.7 X 10^5 m^3/day (150 MGD) was placed into service late in 1975, and now one-half the sewage flow to the Metro plant receives secondary treatment. The remainder is given primary treatment.

Construction in 1976 will bring the secondary treatment capacity to 2.3 X 10^6 m^3/day (600 MGD). The next construction phase including sludge handling facilities will increase Detroit's total treatment capacity to 4.0 X 10^6 m^3/day (1050 MGD) by 1980, one year later than the date reported last year.

The entire flow is chlorinated and ferrous chloride is added for phosphorus removal. Total phosphorus concentrations in the effluent have averaged 3.6 mg P/1. The removal has been less than anticipated because inadequate sludge handling facilities have necessitated discharging sludge in the effluent. This situation is gradually being corrected by the on-going construction program. The scheduled completion of additional treatment capacity and sludge handling facilities at the Detroit plant is shown in Table 9.

The impact on air quality of the additional incineration capacity has recently been questioned and this may affect future handling of sludge at Detroit.

Approximately eighty combined sewer overflow points exist along the Rouge and Detroit Rivers. Information on the frequency of overflow, quantity and quality of discharge is not available although a program to obtain such information is being planned in connection with the Areawide Waste Management Planning Program under Sec. 208, PL 92-500.

TABLE 9

SCHEDULED COMPLETION OF TREATMENT FACILITIES
AT THE DETROIT METRO PLANT

Year	Secondary Treatment (Cumulative Capacity in Operation) (m^3/day)	(MGD)	Sludge Handling Incineration Units
By December 1975	1.7×10^6	450	14
During 1976	2.3×10^6	600	8 (under development) (1976-1980)
By 1980	4.0×10^6	1050	22

Duluth, Minnesota

The Western Lake Superior Sanitary District (WLSSD) is served by nine municipal wastewater treatment plants which will be phased out and replaced by a new 1.7×10^5 m^3/day (44 MGD) pure oxygen activated sludge treatment plant with provision for phosphorus removal. Construction is underway but completion has been delayed to mid-1978 because of equipment delays and additional time required for final approval of plans and specifications for sludge handling.

Industrial wastes from the Conwed Corporation, Potlatch Corporation, Continental Oil and Superwood will also be treated at this new plant which will feature fluidized bed incineration for sludge and solid waste treatment.

Cleveland (Westerly), Ohio

A physical-chemical plant is under construction and when completed in 1980 the 1.9×10^5 m^3/day (50 MGD) facility will be the world's largest physical-chemical treatment plant. This project, plus sewer interceptor work under construction, will aid in abating pollution at the Edgewater Park beach. The Cleveland Regional Sewer District (CRSD) is required by its NPDES permit to prepare plans for overflow control.

Cleveland (Easterly), Ohio

Construction of new screening and grit removal facilities is nearing completion. Plans for combined sewer overflow control are included in the NPDES permit for the facility.

Cleveland (Southerly), Ohio

Several minor construction projects are underway in preparation for a major plant expansion with the entire project expected to be completed in the early 1980's. The CRSD is also required by its NPDES permit to prepare plans for combined sewer overflow control.

Euclid, Ohio

Construction of secondary treatment and phosphorus removal facilities at the 6.6×10^4 m^3/day (17 MGD) plant should be completed in 1978, a year later than previously anticipated.

Gary, Indiana

Secondary treatment and interim phosphorus removal facilities utilizing steel mill pickle liquor are now in operation.

Advanced waste treatment is being required for the protection of the Grand Calumet River. Another project grant awarded in June 1975 will provide much needed improvements to the sewage collection system, including sewer regulator works to control combined sewer discharges.

Niagara Falls, N.Y.

The program under construction is scheduled to provide complete secondary treatment and phosphorus removal by 1976. The plant is designed to treat 1.8×10^5 m^3/day (48 MGD) of municipal/industrial wastewater by a physical-chemical process which includes carbon adsorption. By December 1975, construction was 65 percent complete.

The feasibility of installing temporary phosphorus removal facilities was investigated and it was concluded that this would not be cost effective and would slow the completion of the permanent facilities.

Tonawanda, N.Y. (Sanitary District No. 2)

Treatment facilities to be completed in 1978 will comprise activated sludge followed by metallic salt precipitation of phosphorus and rapid sand filtration. Construction of interceptors and force mains to convey

waste waters from the City of Tonawanda, Spaulding Fibre and the Town of Tonawanda Sanitary District No. 5 was 30 percent complete as of December 1975. Final completion is anticipated in 1978.

Metropolitan Syracuse, N.Y.

Construction contracts were awarded in February, 1975 with the project now about 20 percent completed and scheduled to be finished in 1979. The existing 1.9 X 10^5 m^3/day (50 MGD) primary facility will be upgraded to provide secondary treatment capacity for 3.3 X 10^5 m^3/day (86.5 MGD) of sewage and industrial waste. A new force main and pumping station will convey 2.5 X 10^4 m^3/day (6.5 MGD) of alkaline industrial waste from Allied Chemical Company for phosphorus removal.

Buffalo, N.Y.

The Buffalo Sewer Authority is upgrading its sewage treatment plant from primary to secondary treatment plus phosphorus removal by 1979. During construction, primary treatment and chlorination will be continued. Interim phosphorus removal during construction was considered and deemed to be impractical.

The total project is being carried out under five separate contracts and as of December 1975, construction was 25 percent complete. Secondary treatment facilities for 6.8 X 10^5 m^3/day (180 MGD) are expected to be completed by 1979.

City of Thunder Bay, Ontario

The construction of the new 1.1 X 10^5 m^3/day (24 MGD Imp) primary wastewater treatment plant is well underway and when completed the two existing primary treatment plants will be phased out. The adequacy of treatment is under review by the Upper Lakes Reference Group.

Construction of the major trunk and interceptor sewers is progressing well and is expected to be completed by March 1977, when essentially all of the Thunder Bay area will be serviced with sanitary sewers.

SLUDGE DISPOSAL AND UTILIZATION

Disposal and utilization of the increasing amounts of sewage sludges resulting from improved levels of treatment and phosphorus removal remains one of the difficult problems facing pollution control agencies. Details of current sludge handling programs and practices in Ontario and the Great Lakes states are presented in Appendix C.

Problems associated with sludge disposal are the energy intensive nature of incineration and its potentially adverse effect on air quality, increased volumes and heavy metal contamination of sludge resulting from

phosphorus removal, reliability of sludge handling equipment, odors associated with sludge handling at treatment facilities, unavailability of suitable land for sludge disposal, and the lack of operational technology to apply resource recovery techniques to municipal sludges.

STORMWATER AND COMBINED SEWER OVERFLOWS

Combined and storm sewer overflows continue to be significant causes of water quality impairment in the problem areas identified in this report.

In the *United States*, programs to deal with combined sewer overflows and stormwater discharges have, in the past, consisted primarily of research and demonstration projects under section 105 (a) of PL 92-500. Supplementing the knowledge gained through these programs, emphasis is now being placed upon the planning phase under the Areawide Waste Treatment Management Program authorized by Section 208 of PL 92-500. Combined sewer overflow control is part of the effort to reduce all urban non-point pollution sources. However, as a result of infiltration inflow studies made during the facilities planning process, many municipalities have undertaken cost effective solutions to combined sewer overflow problems in conjunction with sewage treatment plant improvements.

Although projects for correction of combined sewer problems are eligible for construction grants, recent EPA policy on grants for treatment and control of combined and storm sewer overflows makes it extremely difficult to obtain funds. Complex administrative requirements and criteria may preclude funding of many projects. Stormwater control projects, according to the same policy, will not be eligible for funding except in "unusual" circumstances, where similar complex requirements must be satisfied.

In addition, proposed Administration amendments to PL 92-500 would reduce the level of funding provided for solving combined sewer problems to 60 percent from the present 75 percent. Separate storm sewer problem correction would not be eligible for federal funding.

The Board is concerned with this change in approach. Imposing additional administrative requirements and shifting the burden of funding to the local level will inevitably delay correction of combined sewer overflow problems and in many instances, offset the gains from sewage treatment plant construction.

Although several municipalities are proceeding both independently and with federal assistance to correct combined sewer overflow problems, the Board considers that there is a need for a more positively defined policy to provide technical advice and financial assistance to correct these problems. This is particularly important because of the large

estimated costs shown in the 1974 U.S. National Needs Survey of over $6 billion to correct the combined sewer overflow problems in the U.S. portion of the Great Lakes Basin.

Under the *Canada-Ontario* Agreement on Great Lakes Water Quality, programs on urban drainage have proceeded in three phases: defining the magnitude of the problem, developing a management strategy and implementing controls of pollution from urban drainage. An accurate definition of the scope and magnitude of the pollution problem from storm and combined sewer overflows has been completed. Development of a management strategy is well underway with the use of urban drainage models originally developed by U.S. EPA and the U.S. Army Corp of Engineers, modified for Canadian conditions for use in design studies. In addition, studies of regulatory and funding practices in Europe and the United States have been completed, and are being incorporated into proposals for implementation in Ontario. The program is moving into its implementation phase in 1976 with development of various manuals outlining recommended practices and demonstration projects to illustrate alternative design options to reduce the pollution problem from urban drainage.

In Toronto, four of the six boroughs as well as metropolitan Toronto are well advanced in their efforts to correct overflows from combined sewers. A four phased project involving the pick up of overflows for treatment will be completed in 1976 and followed over the next two or three years with automated control for the ccntral operation of overflow points along the sewers.

3 PHOSPHORUS CONTROL AND EUTROPHICATION

The Agreement states that programs shall be developed and implemented to reduce phosphorus inputs to the Great Lakes System. These programs include:

(a) Construction and operation of waste treatment facilities to remove phosphorus from municipal sewage;
(b) Regulatory measures to require industrial dischargers to remove phosphorus from wastes to be discharged into the Great Lakes System;
(c) Regulatory and advisory measures to control inputs of phosphorus through reduction of waste discharges attributable to animal husbandry operations.

In addition, programs may include regulations limiting or eliminating phosphorus from detergents sold for use within the basin of the Great Lakes System.

Specific phosphorus limits of 1 mg P/l were set for the effluents of municipal sewage treatment plants discharging 3.8 X $10^3 m^3$/day (1 MGD) or more to the waters of the Lower Great Lakes System. Similar effluent limitations for the Upper Great Lakes were to be considered after completion of the Upper Lakes Reference Study.

This chapter reviews the status of implementation of these programs, and provides an assessment of their effectiveness and future direction through mathematical modelling studies for Lake Ontario. Details of the control programs are contained in Appendix C. The trophic state of the lakes and status of the mathematical modelling efforts to better understand the potential impact of phosphorus control and provide a basis for future directions are presented in Appendix B.

MUNICIPAL PHOSPHORUS REMOVAL

Interim or permanent phosphorus removal facilities have now been provided at municipal sewage treatment plants processing 72 percent of the municipal sewage flow in the Great Lakes Basin, (Table 10). However, the effectiveness of these facilities falls far short of meeting the phosphorus removal requirements of the Agreement. In Table 11, the actual 1975 phosphorus loadings are compared with the target loadings to be achieved when all treatment plants in the drainage basins

TABLE 10

PERCENT OF MUNICIPAL DAILY SEWAGE FLOW* FOR WHICH INTERIM OR PERMANENT PHOSPHORUS REMOVAL FACILITIES HAVE BEEN PROVIDED

	United States	Canada	Total
Lake Superior	4	0	4
Lake Huron	30	60	39
Lake Michigan	89	-	89
Lake Erie	83	100	84
Lake Ontario	5	84	46
Great Lakes Basin	69	84	72

* - includes all direct dischargers and those indirect dischargers with flows greater than 3.8 X $10^3 m^3$/day (1 MGD)

TABLE 11

COMPARISON OF 1975 MUNICIPAL PHOSPHORUS LOADINGS WITH TARGET LOADINGS

(Kilograms per day of total phosphorus)

	United States		Canada		Total	
	1975 P Loading*	Targeted P Loading**	1975 P Loading*	Targeted P Loading**	1975 P Loading*	Targeted P Loading**
Lake Erie	20,600	7,500	600	650	21,200	8,200
Lake Ontario and St. Lawrence River	5,100	2,100	6,800	2,400	11,900	4,400

* Actual Phosphorus Loading measured at all municipal sewage treatment plants over 3.8 x $10^3 m^3$/day (1 MGD)

** Targeted P Loading: Assuming all plants achieved the effluent objective of 1 mg P/l as required by the Agreement in 1976 for the Lower Lakes. (Based on 1975 Reported Flow).

NOTE: Municipal Phosphorus loading data for 1975 from all municipalities is shown in Appendix C.

of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River attain the limitation of 1 mg P/1. Compliance with this requirement will be assessed in the 1976 Annual Report.

The present operating efficiency of phosphorus removal facilities varies. A study by the IJC Regional Office for the Water Quality Board has shown several major treatment plants in the Lake Erie Basin to have effluent phosphorus concentrations exceeding 1 mg P/1 during 1974 despite the fact that removal facilities were installed in 1973. These plants are Detroit (3.9 mg P/1), Wyandotte (6.7 mg P/1), Cleveland Westerly (2.7 mg P/1) and Toledo (2.2 mg P/1). The predominant difficulty at these plants is the lack of adequate sludge handling facilities.

PHOSPHORUS LIMITATION IN DETERGENTS

Annex 2 of the Agreement suggests that "regulations limiting or eliminating phosphorus from detergents sold for use within the Great Lakes System" be implemented. Canada and the states of Michigan, Indiana and New York currently have limited phosphorus content in detergents to 2.2, 8.8, 0.5 and 0.5% respectively. Minnesota has adopted regulations, effective January 1977 limiting phosphorus content to 0.5% P in detergents. The Commission in its 1973 Annual Report on Great Lakes Water Quality recommended that the United States government seek legislation similar to Canadian law which limits the amount of phosphorus in detergent formulation. In its response to the 1973 Report, the United States Government stated that it has no plans to ban phosphorus in detergents, but will continue to pursue a vigorous program of providing phosphorus removal at wastewater treatment facilities.

Sewage treatment plant data from New York (Table 12), show that reducing the phosphorus content of detergents has resulted in a significantly lower phosphorus concentration in sewage. Detailed discussions and additional data are presented in Appendix C.

Preliminary studies in Canada have suggested that a lower influent phosphorus concentration may require less chemicals to remove the remaining phosphorus from the wastewater. This is evident in cases where metallic salts are used to precipitate phosphorus from sewage.

In summary, phosphorus limitation in detergents can result in reduced chemical costs. Furthermore, with less chemicals and lower phosphorus influent concentrations, the amount of sludge resulting from the separation process is also reduced. This would lessen the costs and problems associated with sludge disposal.

TABLE 12

TRENDS IN RAW SEWAGE
PHOSPHORUS CONCENTRATIONS AS A RESULT OF DETERGENT PHOSPHORUS LIMITATIONS
IN ERIE COUNTY, NEW YORK

Year	Allowable Phosphorus Content in Detergent	Phosphorus Concentration (mg/l) Minimum	Average*	Maximum
1971	No Limit	6.8	12.5	24.5
1972	8.7%P	1.0	5.7	16.3
1973	0%P	1.1	5.3	11.7
1974	0%P	1.2	4.6	10.6
1975	0%P	0.8	2.7	7.1

* Average phosphorus concentration computed from single samples each year from approximately 30 different municipal discharges.

FUTURE DIRECTION OF THE PHOSPHORUS REMOVAL PROGRAM

Most municipalities in the Lower Lakes basin have installed phosphorus removal at their sewage treatment facilities in accordance with the Agreement. The effectiveness of the operation of the facilities in the Lake Ontario basin will be assessed in next year's Annual Report. There have already been some reductions in the phosphorus loadings from municipal sewage discharges to the lakes, and there is also strong evidence that the phosphate limitations in detergents in both Ontario and New York have resulted in a significant reduction in phosphorus loading to Lake Ontario.

The Water Quality Board, as part of its responsibility to provide the IJC with an assessment of water quality and progress toward meeting the objectives specified in the Water Quality Agreement, undertook a modelling study in 1975 - 1976 to evaluate the nutrient reduction program for Lake Ontario.

Mathematical Models of Lake Ontario

Mathematical modelling is an important part of surveillance and provides a tool which can be used to better understand the important processes affecting the Great Lakes. If used properly models can often lead to important new questions, provide direction for surveillance activities, and form the basis for water quality management decisions.

The foremost question raised by the phosphorus reduction program is: What response in terms of lake eutrophication can be expected as a result of ongoing nutrient removal programs? To answer this question a contract was developed by the Surveillance Subcommittee through the IJC Regional Office to accomplish the following:

(a) evaluate the present (1974) phosphorus and nitrogen loads to Lake Ontario,
(b) compile and evaluate historical input loads from 1967 - 1974,
(c) determine various nutrient input scenarios for simulation purposes include the Water Quality Agreement loads, and
(d) simulate long-term effects of the nutrient loads on phytoplankton biomass using the U.S. EPA's existing whole lake phytoplankton model (Lake -1)

In addition, the Surveillance Subcommittee requested the Canada Centre for Inland Waters (CCIW) to assess the effect of phosphorus loadings on phytoplankton biomass using the traditional Vollenweider approach.

The two approaches are similar in that the concentrations of chlorophyll a (to represent the phytoplankton biomass) are related to phosphorus input.

The Vollenweider approach classifies lakes on the basis of an empirical relationship between the mean chlorophyll a concentration and the phosphorus load as a function of the hydraulic loading, depth and residence time. The assumption is sometimes made in attempting to use this model to predict the effects of phosphorus control programs, that the chlorophyll a levels are in equilibrium with present phosphorus loads and as a result any reduction in the loads will result in a rapid response, in terms of reduced chlorophyll a levels. The model does not consider other growth limiting factors such as nitrogen, temperature or sunlight.

The Lake -1 approach which includes a wider range of environmental factors, provides dynamic simulations of chlorophyll a as a function of nutrient reductions and alterations to any of the system parameters (e.g. temperature, inflow, etc.). The problem with this model is the considerable computer and research time required.

The results of the analyses are contained in detail in Appendix B and supporting documents. However the conclusions and recommendations can be summarized as follows:

U.S. EPA Model (Lake -1)

1) Analysis of present and historic nutrient loads to the Lake Ontario system revealed:

   (a) There is no clear trend in loads from Lake Erie to the Niagara River over the period 1967 to 1974.

   (b) From the Niagara River to Lake Ontario there is a trend toward lower phosphorus loads attributed to detergent phosphorus control.

   (c) Municipal and industrial total phosphorus loads to the Lake Ontario basin show a significant decline since 1971. Total nitrogen loads, however, have grown steadily from 1967 to 1974.

   (d) The present (1974) annual total phosphorus load is estimated to be 12,400 metric tons/year (t/a). This compares to 9,000 t/a specified by the Water Quality Agreement's mass loading rate goal. It is estimated that the 1 mg P/l effluent requirement for all municipalities will result in a 7,600 t/a loading rate.

2) An analysis using the Lake -1 Model shows that peak chlorophyll levels may increase under the Water Quality Agreement load reductions. If this is the case, based on present knowledge of the Lake Ontario biochemical system, substantial load reductions must be accomplished in the next ten years to prevent an increase in present biomass levels.

Vollenweider Model

1) Lake Ontario remains in a mesotrophic range. The current load of 12,400 t/a, which is equivalent to 0.65 grams/square metre of lake surface/year (gP/m^2a), is in the transition zone between exceeding an upper loading limit of 0.7 to 0.8 gP/m^2a which would lead to eutrophication and within the lower tolerance limit for 0.36 to 0.40 gP/m^2a believed necessary to maintain the lake's oligotrophic state.

2) Current information indicates smaller loads of phosphorus to Lake Ontario. However, it is not possible to show a trend toward a more oligotrophic condition, although the model predicts that conditions comparable to 1966 - 67 should exist.

Lake Erie Modelling Study

Similar conclusions can be drawn from the recent Lake Erie Wastewater Management Study of the U.S. Corps of Engineers. In the study authorized under PL 92-500, the Corps concentrated on analyzing sources and quantities of phosphorus loadings to the lake. Present phosphorus loading rate is estimated to be 19,600 t/a. A mathematical model which assumes the lakes' three major basins to be "complete-mixed reactors" in series and assumes various physical, chemical and biological transformations of phosphorus within each reactor was used to predict equilibrium phosphorus concentrations in each basin under various loading scenarios.

The Corps considers that, in order to return Lake Erie to a mesotrophic state the phosphorus concentration in the western basin must be reduced from the present 0.037 mg P/1 to 0.020 mg P/1, the central basin from 0.018 mg P/1 to 0.015 mg P/1 and the eastern basin from 0.022 mg P/1 to 0.015 mg P/1. They have concluded that these changes could be achieved in 1 - 6 years after an adequate reduction in applied phosphorus loadings. However, complete elimination of municipal and industrial point discharges of phosphorus will not be sufficient to achieve this since an estimated 40% of the present loadings are from diffuse sources such as land runoff. The Corps is continuing its study in order to develop an economically and technically feasible program to achieve the desired reductions in phosphorus loading to Lake Erie.

SUMMARY

The new estimates of the response of both Lake Ontario and Lake Erie to the phosphorus control programs indicate a delayed recovery of the lakes. Marginal further reductions in the inputs of phosphorus from municipal and industrial point sources are believed to be possible, however, significant amounts are entering the lakes from presently uncontrolled sources: the atmosphere, lake sediments and land drainage. The latter is under study in the Pollution from Land Use Activities Reference Group (PLUARG) and governments have taken initial steps to control phosphorus loadings from land drainage as recommended by the Commission in the Early Action Program of 1973.

Based on the results of these studies the Board emphasizes:

1) the need to achieve 1 mg P/1 or less in municipal sewage effluents as rapidly as possible.

2) that Great Lakes states which have not already done so should seriously consider the imposition of phosphorus limitations in detergents marketed in the Great Lakes Basin.

The Board further suggests that:

1) efforts be continued toward the further scientific development and verification of "lake effect" mathematical models and urges the use

of such models by governments to guide the development and assessment of remedial programs.

3) the economic and technical feasibility of requiring further reductions in phosphorus content of point-source discharges be investigated.

4) the sources and the relative significance of phosphorus loadings from the atmosphere and land drainage be concurrently identified.

5) consideration be given to measures to control further increases in phosphorus loads resulting from new development.

4 INDUSTRIAL POLLUTION ABATEMENT

The industrial programs required to be either completed or underway by 1975 include:

1) the establishment of waste treatment or control requirements for all plants in the Great Lakes System, to provide levels of treatment or reduction of wastes consistent with achievement of the water quality objectives;

2) requirements for substantial elimination of discharges of mercury and other toxic heavy metals;

3) requirements for substantial elimination of toxic persistent organic contaminants;

4) requirements for control of thermal discharges;

5) measures to control the discharge of radioactive materials;

6) programs for compliance monitoring, surveillance and enforcement.

With a few exceptions these requirements have been met by the Governments and the program emphasis has shifted from development of guidelines and related administrative requirements to monitoring, surveillance and enforcement.

In the *United States*, PL 92-500 enacted in 1972 provided for phased installation of two levels of industrial waste treatment technology: Best Practicable Control Technology Currently Available (BPCTCA), generally referred to as Best Practicable Technology (BPT) and Best Available Technology Economically Achievable (BATEA) commonly referred to as Best Available Technology (BAT). Industrial dischargers in the United States are required to achieve BPT by 1977 and BAT by 1983. Achievement of these levels of treatment is considered to be consistent with the objectives and requirements of the

Great Lakes Water Quality Agreement. PL 92-500 sets a further goal of eliminating the discharge of pollutants by 1985.

The first phase of implementing BPT, and more stringent requirements where water quality limitations apply, is underway. Permits are required to be issued for every individual discharge to navigable water specifying effluent limitations based upon a minimum of BPT which is required under the National Pollutant Discharge Elimination System (NPDES) to be achieved no later than July 1, 1977.

The U.S. EPA has continued to publish guidelines defining effluent loadings for BPT for various industrial categories as well as New Source Performance and Pretreatment regulations. A list indicating the current status of the 59 effluent guidelines developed to date is included in Appendix C of this report. Many of these guidelines are being contested in the U.S. Courts. The disputes generally center around the question of proper authority to implement the regulations, and the validity or appropriateness of the actual guidelines.

Ordinarily NPDES permits are issued with final effluent limitations, a specified schedule for attainment of the limits, and interim effluent limitations which essentially require that permitees achieve the maximum reduction in pollutant discharge with existing facilities pending completion of required programs to achieve the final limits. A more complete description of the procedures employed in the development of guidelines and permits is contained in the section on "Industrial Regulations and Enforcement Procedures" of Appendix C.

Over 400 major industrial waste dischargers have been identified in the Great Lakes Basin. A list of these dischargers is included in Appendix C showing the status of compliance of each as of December 31, 1975. The status of each permit is under continuing review by the states and U.S. EPA, and remedial actions are required to be taken whenever violations are detected. In this report, Table 13 shows the estimated dates of compliance with final effluent limits for 76 of the major industrial dischargers in the "problem areas" on the U.S. side.

Fifteen of the significant industrial dischargers to "problem areas" are in the process of exercising appeal rights in adjudicatory hearings contesting the proposed conditions of their NPDES permits. Once these appeals are settled, there may not be sufficient time for many of these industries to plan, design, and construct the necessary facilities by July 1, 1977. Unless Congress changes the law or the Courts grant variances, EPA has no choice but to enforce the deadline. The National Commission on Water Quality has recommended that the law be amended to allow variances with respect to the 1977 deadline in such specific instances and to require strict schedules of compliance to achieve the final effluent limits as soon as possible thereafter.

TABLE 13

EXPECTED DATES FOR THE MAJOR INDUSTRIAL DISCHARGERS IDENTIFIED IN THE "PROBLEM AREAS" TO BE IN COMPLIANCE WITH FINAL EFFLUENT REQUIREMENTS

	AT THE END OF 1975	BY THE END OF 1976	BY THE END OF 1977	
UNITED STATES	Consolidated Paper, Appleton, Wisc. American Can, Green Bay, Wisc. Charmin Paper, Green Bay, Wisc. George Whiting Paper, Menasha, Wisc. Green Bay Packaging, Green Bay, Wisc. Nicolet Paper, West De Pere, Wisc. Mobil Oil Corp., Buffalo, N.Y. Stauffer Chemical (Industrial Chemicals Division) Skaneateles Falls, N.Y. Jones and Laughlin, Cleveland, Ohio Glyco Chemicals, Painesville, Ohio	Conwed Corp., Cloquet, Minn. Potlatch Corp., Cloquet, Minn. Appleton Paper, Combined Locks, Wisc. Bergstrom Paper, Neenah, Wisc. John Strange (Menasha Corp) Menasha, Wisc. Republic Steel, Cleveland, Ohio Olin Corp., Ashtabula, Ohio Allied Chemicals (Dye Plant), Buffalo, N.Y. Union Carbide, Niagara Falls, N.Y. Diamond International Corp, Ogdensburg, N.Y. Campbell Soup, Napoleon, Ohio Sobin Chemical, Ashtabula, Ohio	Superior Fiber, Superior, Wisc. Abitibi Corp., Alpena, Mich. General Motors Corp., Saginaw, Mich. Michigan Chemical, St. Louis, Mich. Dow Chemical, Midland, Mich. Hercules, Harbor Beach, Mich. Mead Corp., Escanaba, Mich. Fort Howard Paper, Green Bay, Wisc. Hammermill, Kaukauna, Wisc. Badger Paper, Peshtigo, Wisc. Kimberly Clark, Neenah, Wisc. Kimberly Clark, Kimberly, Wisc. Atlantic Richfield, East Chicago, Ind. E.I. DuPont, East Chicago, Ind. Union Carbide, Gary, Ind. Great Lakes Steel, Ecorse, Mich. Great Lakes Steel, River Rouge, Mich. McLouth Steel, Trenton, Mich. Monsanto, Trenton, Mich.	Firestone Tire, Riverview, Mich. Pennwalt, Wyandotte, Mich. Gulf Oil, Toledo, Ohio Inter Lake Steel, Toledo, Ohio Standard Oil, Lima, Ohio Harshaw Chemical, Cleveland, Ohio Firestone Tire & Rubber Corp., Akron, Ohio Uniroyal, Painesville, Ohio Union Carbide, Ashtabula, Ohio Donner-Hanna Coke Corp., Buffalo, N.Y. Allied Chemical (Semet Solvay Process), Tonawanda, N.Y. Ashland Oil, Tonawanda, New York Hooker-Chemical (Durez Division), North Tonawanda, N.Y. Hooker-Chemical, Niagara Falls, N.Y. E.I. DuPont, Buffalo, N.Y. Aluminum Co. of America, Massena, N.Y.
ONTARIO	Rio Algom Mines, Township 150 BASF Wyandotte, La Salle Allied Chemical Canada Ltd., Amherstburg	Domtar Packaging Ltd., Red Rock Denison Mines Ltd., Township 150 Abitibi Paper Co. Ltd., Sault Ste. Marie Algoma Steel Corp. Ltd., Sault Ste. Marie Imperial Oil Enterprises Ltd., (Plants 1 & 2), Sarnia Dow Chemical of Canada Ltd., Sarnia Dofasco, Hamilton	Canada Malting Co. Ltd., Thunder Bay Great Lakes Paper Co. (New kraft mill), Thunder Bay Industrial Grain Products Ltd., Thunder Bay Kimberly Clark of Canada, Terrace Bay Eddy Forest Products (Unit #1), Espanola Imperial Oil Ent. Ltd., (Plant #3) Sarnia Omstead Foods Ltd., Mersea Township	

AFTER 1977

UNITED STATES		ONTARIO	
PRESENTLY IN ADJUDICATORY HEARINGS: Inland Steel, East Chicago, Ind. U.S. Steel, Gary, Ind. Youngstown Sheet & Tube, East Chicago, Ind. BASF Wyandotte, Wyandotte, Mich. Standard Oil, Toledo, Ohio U.S. Steel, Lorain, Ohio U.S. Steel, Cleveland, Ohio E.I. DuPont, Cleveland, Ohio Cleveland Electric Illuminating, Eastlake, Ohio Ford Motor Co., Cleveland, Ohio Diamond Shamrock, Painesville, Ohio Allied Chemical (Industrial Chemical Division), Buffalo, N.Y. Republic Steel Corp., Buffalo, N.Y. E.I. DuPont, Niagara Falls, N.Y. International Paper Co., North Tonawanda, N.Y.	PRESENTLY IN LITIGATION; NO PERMITS HAVE BEEN ISSUED: Reserve Mining, Silver Bay, Minn. U.S. Steel Corp., Duluth, Minn. PERMITS HAVE BEEN ISSUED BUT NO FIRM COMPLIANCE DATES ESTABLISHED; COMPLIANCE DATES DEPENDENT UPON COMPLETION OF MUNICIPAL TREATMENT FACILITIES FOR CONNECTION: Carborundum Corp., Niagara Falls, N.Y. Spaulding Fiber Co. Inc., Tonawanda, N.Y.	BY THE END OF 1978 American Can of Canada, Marathon Stelco, Hamilton BY THE END OF 1979 Great Lakes Paper Co. (Kraft mill), Thunder Bay BY THE END OF 1980 Eddy Forest Products (Unit #2), Espanola	CONTROLS INADEQUATE AND UNDER REVIEW BY THE MINISTRY OF THE ENVIRONMENT Abitibi Paper Co. (3 mills), Thunder Bay Great Lakes Paper Co. (Sulphite mill), Thunder Bay Polysar, Sarnia UNDER INVESTIGATION BY A FEDERAL-PROVINCIAL TASK FORCE Eldorado Nuclear, Port Hope

In *Canada*, regulations for each industrial sector are based on the policy that national effluent requirements represent a minimum acceptable base level of effluent quality. The effluent limitations are developed on the basis of applying best practicable technology.

Ontario has agreed to establish and enforce requirements at least as stringent as the national effluent requirements and in practice adjusts these to satisfy local water quality conditions. Under the Canada-Ontario Agreement on Great Lakes Water Quality, the Governments have agreed to the following measures with respect to industrial waste controls necessary to meet the water quality objectives in the boundary waters of the Great Lakes System:

(1) requirements and approval of programs for the construction and operation of industrial waste treatment facilities or control measures.

(2) requirements and approval of programs for the substantial elimination of discharges of toxic heavy metals and toxic persistent organic contaminants.

(3) requirements and approval of programs for the control of thermal and radioactive discharges.

Pursuant to the Ontario Water Resources Act, the province issues Certificates of Approval for the establishment or alteration of works for the collection, transmission or disposal of wastes before any work is undertaken.

All national guidelines and regulations under the Canada Fisheries Act are developed by task forces of representatives from federal and provincial governments and industries concerned. The regulations are promulgated by Order in Council. There is no provision in the regulation development process for direct public review or comment. Implementation of the federal regulations and guidelines have been delegated to the province to minimize duplication of effort. To date, regulations and guidelines have been promulgated for 5 industrial categories and are being developed for an additional 28. Detailed lists are available in Appendix C.

Before issuing a Certificate of Approval for industrial waste treatment facilities, Ontario determines the requirements for the effluent considering both the minimum effluent standards and the impact of the proposed discharge on water quality. In certain cases it has been necessary to formalize individual programs through an "Order" of the Ministry of the Environment, or secure advanced approval of staged programs by a "Program Approval" Directive for measures determined to be necessary to achieve compliance with water quality objectives.

Effluent requirements, establishing both upper and lower operating limits, are set and compared against data and samples submitted by the industry. A record of waste loads and plant performance tested against the effluent limitation is maintained for monthly follow-up action and field inspection as required.

A computerized "Industrial Water Pollution Monitoring System" provides information on the amounts and characteristics of industrial discharges of some 100 major industries which report under the provisions of Section 84(5) of the Environmental Protection Act. Summaries of data are now available by industry classification, body of water and contaminant.

Twenty-eight major industrial dischargers in the Ontario portion of the Great Lakes System contribute to the "problem areas". As of December 31, 1975, all but one were committed to programs of effluent control directed towards achievement of the water quality objectives and a control Order was being considered for the exception. Three of these industries were in compliance with effluent requirements. Five industries were under review where controls were considered inadequate. Waste disposal at Eldorado Nuclear at Port Hope in Lake Ontario was under investigation by a Federal-Provincial Task Force. One plant, a chlor-alkali plant, whose mercury discharges are still creating a problem, was closed in 1973. Nineteen industries in "problem areas" are expected to meet the requirements of the province according to the schedule shown in Table 13. The six industries where present controls are either inadequate or under investigation and review are also shown. The status of compliance for the significant industrial dischargers in the problem areas is provided in Appendix C. Information on other industrial dischargers within the Great Lakes System is on file with the IJC Regional Office.

5 TOXIC AND HAZARDOUS POLLUTING SUBSTANCES

Toxic substances control has become an increasingly important issue in the Great Lakes. While the concentrations of many of these toxic substances are very low in the waters themselves, they may concentrate in the sediments and accumulate in food chains to the detriment of human health and aquatic ecosystems.

The levels of varying environmental contaminants in the higher trophic forms of aquatic life, fish in particular, provide the best means of monitoring and establishing the need for remedial actions to protect the environment. In addition, the Great Lakes fishery represents a valuable resource which must be protected.

This chapter briefly reviews the present status of some of the more important toxic and hazardous substances, PCBs, mercury, DDT and dieldrin, presently impacting the Great Lakes. Information on other possible contaminants in Great Lakes fish such as Mirex, chlordane, HCB, phthalates, cadmium, arsenic, zinc, lead and nickel is scanty. Elevated levels of heavy metals such as zinc, lead and nickel have been found in sediments in harbours and certain inshore areas of Lake Huron and Lake Superior. The presence of these contaminants in fish and the lakes indicates a need for more controls to prevent their loss to the environment and continued surveillance.

The status of efforts to reduce or eliminate the impact of the major environmental contaminants, particularly PCBs is outlined. Details of the levels of persistent contaminants in Great Lakes fish can be found in Appendix B and the control efforts in Appendix C.

Canadian and U.S. legislative and regulatory programs to prevent future contamination of the environment and their applicability to the Great Lakes are also reviewed here and detailed in Appendix C.

Attention was drawn to the presence of persistent contaminants in fish in the 1960's and environmental agencies in Great Lakes states and Canada have been monitoring the most common types, chlorinated hydrocarbons and mercury, since that time. Unfortunately, there has not been an overall design for surveillance of fish contaminants in the Great Lakes and, in most cases, information suitable for interpretation of significant trends is not available. With the exception of the continuous trend-

through-time data provided by Great Lakes Environmental Contaminants Survey (GLECS) and the Ontario Ministry of Environment data on mercury in Lake St. Clair fish, most of the information is local and sporadic. Implementation of the detailed International Great Lakes Surveillance Plan, described later in this report and detailed in Appendix B, will correct the lack of adequate programs for monitoring contaminants in fish.

In addition to bioaccumulation in fish, recent studies have shown that significant amounts of organochlorine compounds are accumulating in herring gulls with adverse effects.

Herring gull eggs collected from each of the Great Lakes in 1974 and 1975 revealed that organochlorine levels are the highest in Lake Ontario and lowest in Lake Erie. PCBs, mercury and Mirex levels are markedly higher in eggs from Lake Ontario than from most of the other Great Lakes. However, levels of DDE and PCBs in Lake Michigan eggs are higher than in Lake Ontario eggs. High levels of Mirex were found in Lake Ontario herring gull eggs, further supporting the recent discovery of Mirex in fish from Lake Ontario.

In 1975, an attempt to define the overall effect of organochlorine residues on the reproduction of herring gulls was initiated by the Canadian Wildlife Service. One colony was selected for study in lakes Ontario, Erie, Huron and Superior. The reproductive success of herring gulls in the Lake Ontario colony was only 1/15th the overall production of the best Great Lakes colony. Significantly, more one egg clutches were observed, fewer of these eggs hatched and fewer of the hatchlings survived 21 days than those for any other lake. Gull colonies in Lakes Superior and Huron had good reproductive success and resembled the profiles of control colonies outside the Great Lakes.

Gulls from the Pigeon Island in Lake Ontario in particular, have been shown to have higher levels of organochlorine residues and lower reproductive success than in the other Great Lakes. Canadian Wildlife Service studies have found adult gulls from Pigeon Island to contain residues of fifteen organochlorine compounds and fourteen polynuclear aromatic hydrocarbon compounds (PAHs) in their tissues. Of the organochlorines found, PCBs were evident in highest concentration followed by DDT and its metabolites. Concentrations of Mirex approached those of DDT.

POLYCHLORINATED BIPHENYLS (PCBs)

PCBs were isolated and identified in the 1960's in connection with the monitoring, analysis and associated research programs of the U.S. Fish and Wildlife Service. Since then PCBs have been recognized as the third most widely distributed environmental pollutant, after DDT and dieldrin, and have concentrated to a significant degree in Great Lakes fish.

PCBs have been used in a variety of commercial and industrial products such as transformers, capacitors, paints, inks, paper, plastics, adhesives, sealants and hydraulic fluids. The main advantages of PCBs are their chemical stability and fire retardant characteristics. Because they are also not readily biodegradable they are widely dispersed throughout the environment - in water, air, landfills, lake sediments, fish and human tissue. The U.S. Food and Drug Administration (FDA) has set the maximum level of PCBs in fish taken from the Great Lakes to be 5 µg/g in its edible portions. In November, 1975, the Canadian Department of Health and Welfare set a temporary guideline of 2 µg/g of PCBs in the edible portions of fish.

At present, about 18,000 t of PCBs are produced annually by Monsanto Chemicals, Inc. the only manufacturer in North America. Although the manufacturer has voluntarily restricted sales of PCBs for use in "closed systems" such as transformers and capacitors, and has indicated an intent to phase out production, the chemical is ubiquitous. There are several causes: importation, accidents during any manufacturing processes using PCBs, formation of PCBs during paper recycling, direct spills into waterways, fallout from the atmosphere due to incomplete combustion of products containing PCBs and leaching from sanitary landfills.

PCB concentrations found in bloater chubs, coho salmon and lake trout from Lake Michigan have not decreased since 1972. In Lake Ontario, a sample of mature coho salmon running into the Credit River in the fall of 1975 contained concentrations of PCBs ranging from 2.6 to 23 µg/g all in excess of the Canadian guideline of 2 µg/g. In addition all salmonid species, white perch, rainbow trout, smelt and American eel in Lake Ontario are carrying elevated body burdens of PCBs.

Concentrations of PCBs in fish from Lake Erie and Lake St. Clair are variable and, for most species, well below the 5 µg/g U.S. FDA guideline. Levels in catfish and white bass from both lakes exceeded the Canadian guideline of 2 µg/g in 1975. PCB residues remain fairly high in Lake Huron fish, particularly salmonids, and there is no evidence of a downward trend.

In the Isle Royale area of Lake Superior, PCB concentrations in lake trout ranged up to 13.8 µg/g. Levels in nearshore areas on the south side ranged up to 4.3 µg/g for lake trout but were considerably less than the guideline for other species. There is no indication yet of a downward trend in PCB concentrations in Lake Superior lake trout.

Despite the voluntary actions in 1971 by Monsanto to reduce the release of PCBs into the environment, residues of the contaminant do not appear to be declining in Great Lakes fishes.

PCBs have been identified in the sediments in lakes St. Clair, Erie and Ontario and are currently being analysed for Lake Huron in current PLUARG studies. In Lake St. Clair, two bottom sediment surveys conducted in 1970 and 1974 showed a decline of 50 percent in PCB concentration. The decrease in sediment bound PCBs is ascribed to the voluntary restraint on PCB use requested in 1971 and the shallow water nature of Lake St. Clair which results in the resuspension of bottom sediment and movement to the Detroit River. A relatively rapid turnover of sediment is thus taking place, resulting in declining levels in the sediments of Lake St. Clair with transfer to the Detroit River and western Lake Erie.

The mean values for PCBs in Lake Erie show that a more than tenfold increase in these compounds has occurred between Lake St. Clair sediment and the sediments of the western basin of Lake Erie. This implies a substantial loading to the Detroit River and the distribution of PCBs in Lake Erie confirms that the river is the predominant source.

There are no known remedial programs for the treatment of PCBs with the exception of incineration at 1200-1400°C (2200-2600°F) although a new microbiological technique is being bench-tested at CCIW. The most effective measure is the elimination of the chemical altogether. Once the chemical has entered the environment, there is relatively little that can be done to remove it. Its persistence ensures that it will be a long term environmental problem.

In the *United States*, following the National Conference on PCBs (Chicago), the U.S. EPA Administrator announced the establishment of requirements through the NPDES program to virtually eliminate PCBs from the process wastes of all manufacturers of PCBs and of capacitors and transformers that utilize PCBs. The issuance of proposed regulations to control the environmental damage resulting from spills of hazardous substances including PCBs was also announced. EPA also published PCB disposal procedures in the April 1, 1976 Federal Register.

A request by EPA to all state governors to carefully examine and apply their authorities to deal with the PCB problem, particularly with respect to waste disposal problems and effluent discharges into municipal systems, contributed to action by Minnesota, Michigan, Indiana and Wisconsin.

Federal agencies will inventory their uses of PCBs and develop plans and adequate management programs for the safe disposal of these materials. In addition, programs to control environmental discharges from other sources of PCBs including paper recycling operations, the metal casting industry, uses in hydraulic systems, and the disposal of electrical consumer products which contain PCBs will be developed.

In *Canada* a federal-provincial Task Force on PCBs reported in June 1976 and reviewed all available information on PCBs. It recommended controls under the new Environmental Contaminants Act as discussed below, and proposed mathematical modelling of pathways of PCBs in the water environment from sources to receptors. A second Task Force was established by the province to focus on provincial control programs under the Water Resources Act. The actions taken by the Ontario Ministry of the Environment are also described below.

MERCURY

Commercial fishing in Lake St. Clair and fishing for walleye in the western basin of Lake Erie have been banned since 1970 due to mercury contamination. Shortly after 1970 mercury was found to exceed the U.S. FDA and Canadian NHW guidelines of 0.5 µg/g in at least one species of fish from each of the Great Lakes except Lake Michigan. Mercury residues in Lake St. Clair fish have declined about 60% since 1970 but levels remain above the 0.5 µg/g guideline. A similar decline of 60% was observed in the mean concentration of mercury in Lake St. Clair sediments between 1970 and 1974.

In Lake Erie mercury concentrations in many species of fish also declined but still exceed the guideline in larger sizes in the western basin. In Ontario, opposite Essex and Kent counties, restrictions are in effect for yellow pickerel.

The New York Department of Environmental Conservation reports that mercury levels in fish from Lake Ontario have not decreased significantly since 1973 and in some species remain above the guideline. Because of mercury contamination, commercial fishing for eels, yellow perch and pike is restricted in the St. Lawrence River from Kingston to Cornwall, Ontario.

In 1975 residues in northern pike and walleye in Lake Huron approached the guideline and the mean value for walleye from Nottawasaga Bay exceeded it.

In the Marathon area of Lake Superior residues of mercury in lake trout and whitefish continue to exceed the guideline. This is also true of lake trout in Black Bay, Thunder Bay and Nipigon Bay, in walleye in Pine Bay and in sculpins in the Knife River area. Fat lake trout in the nearshore area of Michigan waters of Lake Superior also have mercury levels in excess of 0.5 µg/g.

DDT

DDT levels in fish from Lake Michigan declined significantly between 1969 and 1974 to below the 5 µg/g U.S. FDA guideline except in large

lake trout. However, in Lake Superior, where concentrations in lake trout also exceed 5 µg/g, average values of DDT have not decreased from the levels reported previously.

DDT concentrations in fish from Lake Huron, Lake St. Clair, Lake Erie and Lake Ontario do not exceed the guideline.

DIELDRIN

Although the pesticide dieldrin was banned for agricultural use in Ontario in 1969 and in the United States in 1974, there does not appear to be any downward trend in the concentrations found in Great Lakes fishes. While levels are generally less than the 0.3 µg/g U.S. FDA guideline, they have persisted since first being measured in the mid 1960's.

TOXIC SUBSTANCES CONTROL

In the *United States*, Congress is considering a Toxic Substances Control Act which would require a 90-day pre-market notification to U.S. EPA by manufacturers of all new chemicals prior to production. However, the FY 1977 Federal budget proposed by the Administration shows no plans for toxic substance control measures. If Congress accepts this proposal, funding for EPA's programs in toxic substance and pesticide control would be reduced. U.S. EPA, Region V has identified specific chemicals which are currently requiring its attention, chemicals which are showing up in fish and other compounds such as pesticides which may contaminate drinking water or fish.

The Lake Michigan Toxic Substances Committee representing state and federal environmental agencies has summarized research on the effects of PCBs on both fish and humans and recommended a national ban on all domestic and imported PCBs destined for use other than in transformers and capacitors. The Committee has also recommended a critical review of current PCB usage in view of possible substitutes.

The states of Indiana, Minnesota, Michigan and Wisconsin have passed legislation or developed regulations essentially banning the use of PCBs except for electrical transformer use.

In *Canada*, the Environmental Contaminants Act was passed in late 1975 and proclaimed April 1, 1976, by the Governor General. The intent of this Act is preventative; it can regulate the introduction, use, distribution and processing of materials in quantities greater than 225 kg (500 lbs.) per year. Under the Act, an Environmental Contaminants Board of Review will be formed by the Departments of Environment and National Health and Welfare to inquire into any substances suspected of

constituting a danger to human health or the environment. One of the first substances to be regulated will be PCBs.

The Act will also establish an inventory assessing all chemicals in commercial use vis-a-vis various contaminant criteria. Such a data base will enable the Government to investigate, restrict or limit the use of any chemical believed to be deleterious to the environment or human health.

In Ontario, the Provincial Minister of the Environment served notice to industries on November 18, 1975 of the need to develop alternate, harmless materials to replace PCBs in products. The government has urged the replacement of PCBs and control of their importation as soon as possible to compliment the Environmental Contaminants Act. Control of the dispersal of PCBs presently in use is possible at the federal level through the Fisheries Act, and at the provincial level through the Water Resources Act, and work has begun to determine the feasibility of such controls.

HAZARDOUS POLLUTING SUBSTANCES

A proposed list of hazardous substances has been designated by U.S. EPA in accordance with Section 311(b) of PL 92-500. Such designation provides the foundation for the regulation of transportation of hazardous substances, including PCBs. Notices of rulemaking on the determinations of removability, harmful quantities, units of measurement and rates of penalty were also published on December 30, 1975 (F.R. 40, No. 250) with a 60-day period for public review and comment.

In accordance with the terms of the Agreement, the Parties have been in consultation for the purpose of developing an Annex to identify hazardous polluting substances. Representatives of the two Governments met in December 1975 to exchange views on lists of hazardous polluting substances based on previous meetings in April, July and November of 1975. A proposed technical draft was prepared at the December meeting and procedures adopted for its completion. This has since been done and the final draft forwarded to the State Department and External Affairs for approval.

6 RADIOACTIVITY

This chapter summarizes the status of the development of a refined water quality objective for radioactivity, the radioactivity surveillance plan, distribution of nuclear facilities in the Great Lakes Basin, and current levels of radioactivity in the Great Lakes. Details of the above are contained in Appendix D, the Report of the Radioactivity Subcommittee.

REFINED WATER QUALITY OBJECTIVE FOR RADIOACTIVITY

The Agreement contains a "specific" water quality objective for radioactivity in Annex 1, Item 1. (h):

> Radioactivity. Radioactivity should be kept at the lowest practicable levels and in any event should be controlled to the extent necessary to prevent harmful effects on health.

However, Item 7 states:

> Consultation. The Parties agree to consult within one year from the date of entry into force of the Agreement, for the purpose of considering:
>
> (b) Refined objectives for radioactivity and temperature; for radioactivity the objective shall be considered in the light of the recommendations of the International Commission on Radiation Protection.

The charge to develop a refined radioactivity water quality objective was invested in two Radioactivity Advisory Groups, one Canadian and one U.S., established directly by the Parties.

These Advisory Groups have developed a proposed water quality objective for radioactivity in terms of a radiological dose equivalent (TED_{50}) of not more than one millirem to the whole body of an International Commission on Radiation Protection (ICRP) reference man imbibing a standard annual intake (2.2 l/day) of Great Lakes water. Action levels and a source control zone with a 1 km radius about the discharge point have also been proposed.

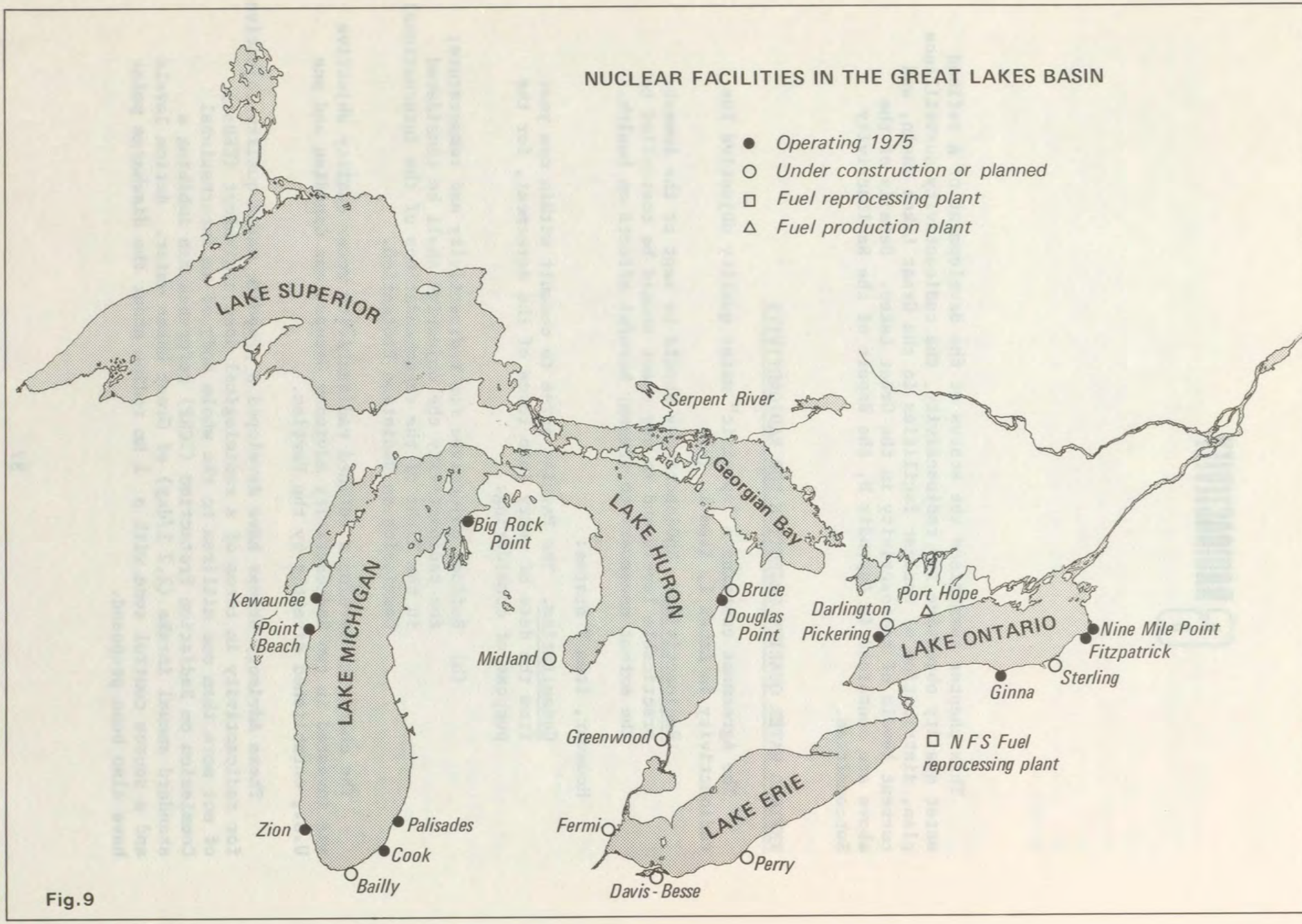
NUCLEAR FACILITIES IN THE GREAT LAKES BASIN
● Operating 1975
○ Under construction or planned
□ Fuel reprocessing plant
△ Fuel production plant
LAKE SUPERIOR
Serpent River
Georgian Bay
LAKE HURON
LAKE MICHIGAN
Big Rock Point
Kewaunee
Point Beach
Midland
Bruce
Douglas Point
Port Hope
Darlington
Pickering
LAKE ONTARIO
Nine Mile Point
Fitzpatrick
Sterling
Ginna
Greenwood
□ N F S Fuel reprocessing plant
LAKE ERIE
Zion
Palisades
Cook
Bailly
Fermi
Perry
Davis - Besse

Fig.9

The proposed objective is now undergoing internal review by the concerned federal, state and provincial agencies prior to anticipated public hearings and adoption. The majority of the Board would support the Parties adopting the objective as part of the Agreement prior to they or the Commission holding public hearings on it. However, some members would prefer to have the objective referred to the Commission for review prior to adoption.

RADIOACTIVITY SURVEILLANCE PLAN

The Board's Radioactivity Subcommittee has developed a Radioactivity Surveillance Plan which proposes regular sampling of lake water in three critical areas:

1. At the periphery of each nuclear facility's source control zone to check compliance of point source inputs.
2. In the open waters to ensure that the ambient water quality objective is being met.
3. At selected water intakes to determine radiological dose rates to the population drinking water from the Great Lakes.

The Radioactivity Surveillance Plan is given in Appendix D. It has been integrally incorporated into the overall Surveillance Plan for the Great Lakes developed by the Surveillance Subcommittee and detailed in Appendix B.

LOCATIONS OF NUCLEAR FACILITIES

Nuclear facilities in the Great Lakes Basin include 16 nuclear power reactors, a fuel reprocessing plant, a uranium refinery and UF_6 production facility, and mining and milling operations (Figure 9). Table 14 lists the present reactors and their electrical output. Additional facilities planned in the Basin are summarized in Figure 9 and Table 15.

CURRENT LEVELS OF RADIOACTIVITY IN THE GREAT LAKES

Some radioactivity monitoring programs regularly check inshore surface waters and biota near operating nuclear facilities. In addition, open water radioactivity data are collected in conjunction with baseline or special studies. Together, these permit a semi-quantitative assessment of

TABLE 14

OPERATING NUCLEAR GENERATING STATIONS 1975

Lake	Station	Location	Reactor Type	Electrical Power, MW
MICHIGAN	Zion I & II	Zion, Illinois	PWR	2 x 893
	Kewaunee	Carlton, Wisconsin	PWR	541
	Point Beach I & II	Manitowoc County, Wisconsin	PWR	2 x 497
	Palisades	Covert Township, Michigan	PWR	700
	Big Rock Point	Charlevoix County, Michigan	BWR	75
	Cook I	Benton Harbor, Michigan	PWR	1060
HURON	Douglas Point	Kincardine, Ontario	CANDU	220
ONTARIO	Pickering A	Pickering, Ontario	CANDU	4 x 540
	Ginna	Ontario, New York	PWR	490
	Fitzpatrick	Oswego, New York	PWR	821
	Nine Mile Point I	Oswego, New York	BWR	625

TABLE 15

NUCLEAR GENERATING STATIONS UNDER CONSTRUCTION OR PLANNED

Lake	Station	Location	Reactor Type	Electrical Power, MW	Est. Compl. Date
MICHIGAN	Baily 1	Westchester Twnsp. Indiana	BWR	645	1979
	Cook 2	Benton Harbor, Michigan	PWR	1060	1977
HURON	Midland 1 & 2	Midland, Michigan	PWR	2 x 818	1980
	Bruce A	Kincardine, Ontario	CANDU	4 x 750	1976
	Bruce B	Kincardine, Ontario	CANDU	4 x 750	1983
ST. CLAIR RIVER	Greenwood 2 & 3	St. Clair Co., Michigan	PWR	2 x 1200	1983
ERIE	Fermi 2	Monroe Co., Michigan	BWR	1093	1978
	Davis-Besse 1, 2 & 3	Ottawa Co., Ohio	PWR	3 x 906	1976-83
	Perry 1 & 2	Perry Co., Ohio	BWR	2 x 1205	1980
ONTARIO	Nine Mile Point 2	Oswego, New York	BWR	1080	1978
	Sterling 1	Sterling, New York	PWR	1150	1982
	Pickering B	Pickering, Ontario	CANDU	4 x 540	1982
	Darling-ton	Oshawa, Ontario	CANDU	4 x 750	1985

the radioactivity quality of the Great Lakes. The proposed radioactivity surveillance plan would permit a better assessment. Radioactivity data for 1974 are given in Appendix D and for previous years in a July 1975 report by the Radioactivity Work Group.

The monitoring results available from various agencies point to the fact that man-made radionuclide concentrations in the waters of the Great Lakes are still essentially due to atmospheric fallout of nuclear weapons testing debris and are remaining constant. However, local environments around nuclear facilities on the shores of the Great Lakes show evidence of radionuclides discharged to the lakes.

Lake Ontario water intakes near the Pickering nuclear generating station just east of Toronto have shown occasional above-background levels of ^{137}Cs during 1974 and 1975. Tritium levels in surface water near the Pickering discharge were found to be about five times higher than open lake levels. Aquatic vegetation and fish harvested in the neighbourhood of the R.E. Ginna station near Rochester and the Nine Mile Point station east of Oswego in 1974 were found to contain measurable quantities of reactor produced radionuclides.

In 1974, the levels of the radionuclide ^{226}Ra in the inshore water of Lake Ontario near Port Hope, were below the Ontario permissible criterion for public surface water supplies of 3 pCi/l . The levels during 1975 exceeded this at four stations inside the harbour where refinery waste had been released in the past. At one station in the lake just offshore from the Port Granby waste disposal site, data from samples taken in September and October 1975 showed levels similar to the Ontario criterion for public surface water supplies. Periodic samples of the Port Hope water supply show levels of ^{226}Ra to be less than 1 pCi/l, within the Ontario drinking water criterion.

Lake Erie showed no effect of the nuclear fuel reprocessing plant on Cattaraugus Creek and only weapons fallout and natural radionuclides were present during 1974.

No measurable effect of the Douglas Point nuclear generating station on Lake Huron was observed during 1974 although an accidental release of tritium to the lake was reported for July 1973. The concentration of ^{226}Ra at the mouth of the Serpent River which drains the Elliot Lake uranium mining district, was reported at 5.4 pCi/l for 1975, again higher than Ontario's permissible limit of 3 pCi/l. Annual results reported from 1966 through 1975 show a slow decline in ^{226}Ra concentrations at this point.

As a result of a regulated release of contaminanted laundry wastes, high levels of ^{137}Cs and ^{134}Cs were reported near the Palisades nuclear generating station on Lake Michigan in May 1974. Such controlled discharges and the possibility of accidental releases of radioactive materials from operating nuclear power generating stations during an excursion, emphasizes the need for continued environmental surveillance.

Lake Superior has no nuclear facility on its shoreline and levels of weapons fallout radionuclides in the water were similar to 1973.

The radiological dose received by the population of the Great Lakes basin during 1974 from drinking water from individual lakes would have been essentially due to fallout ^{90}Sr. The calculated TED_{50} values for ICRP standard reference man for the lakes were: Superior 0.3 millirem, Michigan 0.5 millirem, Huron 0.5 millirem, Erie 0.6 millirem, and Ontario 0.6 millirem, calculated on the basis of the principles given in ICRP Publication No. 10 (1968) - "Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure". The Publication No. 10 calculations were modified to convert the mineral bone dose to an equivalent bone marrow dose.

7 LAND USE

The Governments have adopted a variety of measures to control pollution from land use activities. This Chapter and Appendix C, review progress made in this area. Concurrently Governments are participating with the Commission to conclude the reference on "Pollution in the Great Lakes System from Agricultural, Forestry, and Land Use Activities" and a definitive report on the broader aspects of the land drainage problem is expected in 1978.

URBAN LAND USE DEVELOPMENT AND CONSTRUCTION

In the *United States* water quality planning is taking place under the Areawide Waste Treatment Management Program, Section 208 of PL 92-500. This program deals with the issues of land use and public and private development in terms of their environmental implications. It includes not only pollution from municipal and industrial point sources, but also nonpoint sources such as runoff from urban, rural and agricultural lands, and erosion at construction sites. Such planning and management is now required throughout the states as well as in specially designated areasand are currently underway in 18 metropolitan areas of the Great Lakes Basin.

Several studies are underway in the United States to determine quantity and quality of urban runoff. The Washington County Project in the Menominee River Basin of Wisconsin is attempting to measure sediment losses in a rapidly urbanizing area. The goal of the project is to demonstrate the effectiveness of various land use controls to improve water quality and to devise the necessary institutional arrangements for the preparation, acceptance, and implementation of a sediment control ordinance. The project involves intense monitoring efforts, especially to document the relative effects on water quality of high intensity construction versus normal urban and agricultural areas. This study is coupled with a PLUARG Pilot Watershed Study on the Menominee River which will determine levels and quantify other parameters such as metals, nutrients and pesticides in addition to sediment. Findings are to be extended to other areas of the basin.

Sediment control requirements have been established by the states of Wisconsin, Michigan, Ohio, Pennsylvania and New York.

The need for a more positively defined policy and continued funding in the United States for the correction of stormwater and combined sewer overflows was discussed in Chapter 3.

In *Canada*, the Province is giving direction and guidance to the development of the five planning regions in Ontario. Development plans may be required by the Province for a development area under the Ontario Planning and Development Act, 1973. These plans enunciate policies for the economic, social and physical development of an area; policies on financing and programming of public development projects and capital works, and policies to coordinate and implement planning and development among municipalities within a development area.

The Act provides for the management of land and water resources and the control of all forms of pollution of the environment among other aspects of planning. Plans developed under the Act are to be guided by the environmental planning policies of the Province with the Environmental Assessment Act employed to ensure this consistency. The Federal Regional Development Incentives Act and the National Housing Act are considered to be complementary measures supporting provincial and municipal policy objectives in planning future land use.

Working guidelines used by the Ministry of the Environment describe requirements for construction contractors to control erosion and sedimentation and to prevent contamination from other sources during and after construction. The intent of these guidelines is to protect property, implement downstream flood protection and erosion control measures and control the quality of storm runoff.

Measurements are being made of the quantity and quality of urban land drainage, for both storm and dry weather flows, in several municipal studies. As described in Chapter 3, studies are underway to develop stormwater management systems for Ontario municipalities and a number of major combined sewer separation programs are underway.

SHORELINE AND RIVERBANK EROSION AND SEDIMENTS

In the *United States* the Flood Disaster Protection Act of 1973, administered by the Housing and Urban Development Administration (HUD) requires communities to apply for federally funded flood insurance. In order for the application to be approved the communities must have flood plain zoning that prohibits any building within the flood plain. Homes that are presently in the flood plain may then obtain flood insurance. This is resulting in a nationwide effort in mapping flood plains in the United States. In the Great Lakes Basin the states are doing studies to

determine recession rates and erosion along the shoreline. These state studies are being evaluated by PLUARG. Also underway, by the Great Lakes Shoreline Damage Reduction Task Force, in cooperation with the U.S. Army Corps of Engineers and other federal, state and local agencies is a shoreline survey to provide data necessary for regulatory and management agencies to guide zoning, setbacks and other shoreline uses. These efforts are coordinated with Coastal Zone Management Programs and the Great Lakes Basin Commission, which is involved in complementary studies for PLUARG.

Michigan has established a low cost erosion control demonstration program. Twenty-two sites in Michigan are presently being studied using a variety of devices to demonstrate erosion control. A similar federal program will provide a demonstration for the Great Lakes.

The Black Creek project in Allen County, Indiana, funded under Section 108(a) of PL 92-500, is a broad and comprehensive study of erosion and sediment control to demonstrate the impact on water quality in the Maumee River and Lake Erie. The project involves actual implementation of a multi-agency approach to the control of non-point source pollution.

The Red Clay area of Wisconsin is the subject of another 108(a) demonstration project involving the use of both structural and non-structural land treatment measures to reduce the sediment input from erosion of the red clay soils. The goal of the project is to demonstrate the effects of the erosion on the quality of Lake Superior and develop an action program for shoreline and riverbank erosion and sediment control.

In *Canada*, a Canada-Ontario Great Lakes Shore Damage Survey Report was completed and is being prepared for release.

Work has also continued on sediment sampling on several streams in the Lake Ontario, Lake Erie and Lake Huron drainage basins. Studies begun last year on the Credit, Bronte, Humber, Welland and Niagara rivers were extended in 1975 to the Grand, Saugeen, Thames and Nottawasaga rivers. Samples taken every three weeks have been examined for trace metals, pesticides, PCBs, major nutrients including phosphorus, and organic carbon and nitrogen. As well, all streams in the Great Lakes Basin were examined for suspended solids in the spring runoff period.

Preliminary findings suggest a remarkable consistency in sediment quality from stream to stream with variations occurring with time of year. Changes in river discharge levels account for variations in the sediment load carried by the tributaries.

TRANSPORTATION

In the *United States'* portion of the Basin little change has been documented since last year's report regarding existing sources of water pollution related to transportation. New facilities frequently require the preparation of Environmental Impact Statements, which have become an effective tool for ensuring the consideration of water quality consequences in the construction, maintenance and operation of roads, airports, utility lines, etc.

In *Canada*, Ministry of the Environment guidelines describe measures to control water pollution during the construction, maintenance and operation of transportation corridors. New construction will be regulated under provincial environmental legislation.

Studies are underway in controlled highway corridors to measure the magnitude and impact of pollutants such as metals, salts, sediments and herbicides contained in roadway and adjacent right-of-way runoff.

A series of landfill sites has been designated as satisfactory for the disposal of contaminated debris associated with spills because of location, soil type, groundwater protection, supervision, etc. in connection with the Ontario Contingency Plan for spills of oil and chemicals or other hazardous contaminants or toxic agents.

DREDGING AND SHORELINE LANDFILLING

In the *United States* during 1975, the U.S. Army Corps of Engineers was involved in dredging of numerous authorized project channels and harbours where approximately $6.5 \times 10^6 m^3$ of material were dredged. In addition, a total of 1130 permits were issued for dredging approximately $1.4 \times 10^6 m^3$. Among these the largest were Calumet Harbor - by U.S. Steel and the Maumee River - by the Toledo-Lucas County Port Authority about $3.0 \times 10^5 m^3$ each.

In *Canada*, there is concern that present dredging and shoreline landfilling practices will lead to a significant loss of wetland areas. Recommended practices and procedures to minimize environmental impacts of landfilling, dredging, spoils disposal and lakeshore development are described in the Ontario Ministry of the Environment guidelines employed by federal and provincial agencies.

PESTICIDES

In 1973 the Commission recommended to the Governments that systematized pest control product use inventory programs should be established in the Great Lakes Basin by the appropriate jurisdictions.

In the *United States* prior to this, the Governors' Great Lakes Regional Interdisciplinary Pesticide Council, representing the states of Illinois, Indiana, Michigan, Minnesota and Wisconsin, prepared a 1971 survey of the general farm use of pesticides. Due to lack of funding there have been no systematic inventories of pesticide use since that time. Minnesota and Wisconsin monitor pesticide use, and other states gather information as needed.

The U.S. EPA is investigating the use of herbicides on major crops in Region V, and the use patterns of particular pesticides. Unfortunately, most surveys are based on estimates of use rather than on statistically valid survey methods.

Currently, all basin states require registration of commercial pesticides and regulate the distribution of restricted pesticides. However, few states have statutes aimed at regulating the impacts of pesticides on water quality, other than regulating the use of aquatic herbicides, and pesticide disposal. State management and control of pesticides range from outright banning of certain pesticides to restricting areas of pesticide usage. Most states limit pesticide regulations use procedures to agricultural or commercial application and do not regulate the use of general household pesticides.

PLUARG recently completed a report on "Materials Usage in the United States - Great Lakes Basin - September 1975". The study calculated the amounts of herbicides, insecticides, and fungicides used on crops, and inventoried the types and acreage of various crops, pastures, vegetables and fruits. The common rates of application were then multiplied by the acreage treated. To date, there has been no organized effort to obtain continuing pesticide use information on a regional or state-by-state basis, as now exists, for crop reporting. Improved inventory programs would be feasible, if resources are made available, either through the auspices of the Governors' Interdisciplinary Council, or through individual state agencies.

The U.S. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended in 1972, requires that a program for the certification of private and commercial applicators using pesticides designated for "restricted" use be operational by October 1977. State agencies have the primary responsibility for applicator certification and legislation and are developing plans for the administration of the program. Training and examination of applicators has been initiated in anticipation of the October 1977 deadline.

FIFRA also gave the national pesticide monitoring program legislative status and gave U.S. EPA authority and responsibility for coordinating a wide ranging program. The program includes monitoring of pesticide residue or metabolite levels in water, soil, crops, air, human tissue, wildlife, estuarine fish and shellfish to determine the concentration, movement, and in some cases the origin of the residues. Research on the degradation rates of pesticides, including formation, fate and toxicity of

degradation products is being conducted at industrial, university, and private laboratories. The U.S. EPA publication, Pesticides Abstracts, summarizes this and other information.

The characterization of pesticide and nutrient transport in a fruit orchard watershed is the object of the Mill Creek study in Michigan. This PLUARG Pilot Watershed Study will document the lateral and vertical transport paths of pesticides, herbicides and nutrients in the soils to the stream. The study will document the pesticide usage and relate it to effects on water quality.

In *Canada* all pesticides that are sold must be registered. The registration of pesticides is controlled by the Pest Control Products Act administered by Agriculture Canada. Each pesticide is registered for certain uses. Pesticides with undue environmental impact or undue toxic effects are either banned or severely restricted in use.

In Ontario, the sale and use of pesticides is rigidly controlled under the Pesticides Act. Registered pesticides are classified into four categories on the basis of their toxicology and potential environmental impact. Their distribution, availability and use are regulated accordingly. The very toxic and persistent pesticides in the restricted category are available on a specific use permit and the outlet selling them must keep complete sales records. This enables the Ministry of the Environment to maintain a comprehensive inventory of restricted pesticides being used in Ontario. The less persistent and low toxic pesticides with no environmental impact are available to the home gardener. Sampling for toxic materials in milk, avian fat, beef fat, eggs and soil is conducted regularly and the data are published.

ANIMAL WASTES AND FERTILIZERS

In the *United States* significant changes have been made recently with respect to the control of animal wastes. Requirements issued in March 1976 establish conditions under which concentrated animal feeding operations are considered point sources of pollution and subject to NPDES permit requirements. This was a significant result of the United States District Court ruling in June 1975 that U.S. EPA, which previously had exempted smaller feedlots from the permit program, must determine the point sources of pollution in that category and place them within NPDES. Control of pollution by runoff from agricultural lands is recognized as a major problem in the Areawide Waste Management Planning Program.

In *Canada*, a new Ontario Code of Practice has been developed for manure utilization. It is designed to encourage optimum use of nutrients and to avoid pollution of surface and groundwaters. Odor control and nuisance to the public are also considered. Guidelines are being considered for the application of processed fluid sewage sludge to

agricultural land used for corn, grass-hay, and commercial sod crops where the need for phosphorus and nitrogen supplements is indicated. Other crops are also being considered for possible applications of sewage sludges, however, these have additional restrictions on the metal content of soil.

FORESTRY

In the *United States*, management of forestry operations to prevent adverse effects on water quality is controlled by both federal and state governments. State sediment control and pesticide regulations apply to land-use activities in private forests and in some cases, such as Michigan, to federal forests. Section 208, PL 92-500 also provides a mechanism for identification and control of non-point sources of pollution from silvicultural activities.

In *Canada*, most forest operations are carried out under crown licenses and are regulated by the provinces. In Ontario guidelines are employed by operators in preparing plans for new activities in forest management and future proposals will be subject to the Environmental Assessment Act.

MINING

In the *United States* surface mining is extensively regulated with procedures requiring land reclamation, backfilling, grading, planting and prevention of groundwater degradation. There are, however, obvious problems with mining wastes as demonstrated by the case of Reserve Mining in Minnesota. Regulations are also in place for the control of acid mine drainage for underground operations. Section 208, PL 92-500 also provides an opportunity for the control of mine related sources of pollution. During the past year Ohio and Pennsylvania have passed regulations that specify procedures for the rehabilitation of mined lands, and control of the quality of drainage.

In *Canada*, the Province of Ontario employs guidelines and procedures for construction and maintenance operations related to land based mining activities, subaqueous mining and offshore drilling. Separate guidelines for the handling and disposal of mine waste materials have also been prepared. Major mining proposals will be considered under the Environmental Assessment Act.

RECREATION

There has been a significant increase of recreational land use activities in the past several decades. In all jurisdictions in the Great Lakes Basin, general water quality regulations and standards are applied to control pollution from such activities. Existing laws on

sediment control, animal wastes and application of pesticides and herbicides are effective to a limited extent in controlling recreational land use practices. The main difficulty lies in establishing control procedures to ensure observance of such regulations by individual users.

Ontario Government guidelines are available for marina construction, cottage development and small dam construction and the installation and maintenance of private septic tank systems.

SURFACE DISPOSAL OF LIQUID AND SOLID WASTES

In the *United States*, federal legislation is pending in both the House and Senate to regulate disposal of hazardous wastes. Proposed laws would establish state program grants, and require state management plans. State and local implementation plans will also be required. A permit program for disposal sites would be a key element of such a program. In the immediate future, the Office of Solid Waste Management Programs, which coordinates sludge management policies within U.S. EPA, is expected to propose regulations for handling hazardous wastes.

In *Canada*, a Waste Management Advisory Board has been established to advise the Ontario Ministry of the Environment on any matter related to waste management.

Regulations made under Ontario's Environmental Protection Act require the certification of waste management systems and organic soil conditioning sites for the disposal of processed organic waste. In addition, guidelines are being finalized for the utilization of sewage sludge for its nutrient value in crop production. Regulations have also provided standards for the location, maintenance and operation of landfilling sites.

Ontario regulates the hauling and disposal of sewage sludge through certification of waste disposal sites and waste management systems.

Implementation of the municipal phosphorus removal program has increased the volume of sludge produced and its composition has been significantly altered. Limits will be established for other heavy metal impurities in aluminum and iron salts used for phosphorus removal.

Studies are being conducted of the effects on water quality of processed organic wastes placed on land and the production of leachate, its composition, the pattern of migration and attenuation at a landfill site.

The Ontario Resource Recovery Program, a long term program to promote recovery and recycling of resources is now being implemented. This program will, in time, reduce the use of sanitary landfills for waste disposal, and the volume of waste to be disposed of, and will provide for material and energy recovery.

SUBSURFACE DISPOSAL OF LIQUID WASTES

In the *United States* the disposal of liquid wastes in subsurface formations through deep wells is relatively inexpensive. However, the waste effluents may undergo subsurface migration and infiltrate ground water supplies. The Great Lakes states therefore have legislation or statutes to discourage or closely regulate waste disposal by underground injection. Contamination of underground aquifers is also possible through seepage of wastes placed or stored near the ground surface.

The Safe Drinking Water Act of 1974, PL 93-523, establishes requirements for regulations controlling underground waste disposal in all states. U.S. EPA regulations still to be issued will become effective in December 1977 and will be an additional step in ensuring that subsurface waste emplacement in the United States will not contaminate water resources.

In *Canada*, Ontario's policy is to reduce to the absolute minimum the use of deep wells for liquid waste disposal. Preference is given to methods of reclamation, reuse and incineration and only where no better method of disposal exists are approved liquid wastes accepted for disposal into the Cambrian formation.

8 DREDGING

The International Working Group on the Abatement and Control of Pollution from Dredging Activities was established in 1972, pursuant to Annex 6 of the Agreement. Its final report was submitted to the Governments in May, 1975.

The Working Group was directed to review dredging practices and programs in the Great Lakes as well as the relevant laws and regulations governing dredging. The intent was to develop compatible criteria for the characterization of dredged material and to recommend compatible programs governing the disposal of polluted spoil in open waters.

The Working Group concluded that there are no single parameter values which could be adopted as universal criteria for designating "polluted dredge spoils" applicable throughout the Great Lakes. It recommended a site-specific assessment of the hazards and potential benefits of each project within its particular environment through a selection of indicator parameters derived from baseline information on water and sediment quality and known sources of potential contaminants. Moreover, the Working Group recommended that guidelines on dredging be accomplished by administrative action to allow some flexibility in meeting the changing responsibilities of different agencies and jurisdictions.

The report also advised that a standing committee be formed to audit dredging activities in the Great Lakes and review assessments of individual projects to ensure compliance with recommended guidelines. Such a committee would provide a logical focus for encouraging the exchange of information from continuing research activities and accumulated experience and would be able to recommend appropriate changes in criteria and guidelines to reflect technological advances as they occur.

The Board was disappointed that the Working Group was unable to recommend universal criteria for designating polluted dredge spoils, rather than the site specific assessment which the Board considers unduly burdensome to regulatory agencies. However, if the standing committee as proposed by the Working Group is established under the IJC, as the Board recommends, the Board would encourage further examination of the two approaches by the standing committee.

9 SHIPPING AND RELATED ACTIVITIES

The Parties agreed to develop measures to control pollution from shipping activities through the adoption of compatible regulations for the control of vessel wastes (Annex 4) and the consideration of vessel design, construction, operation, navigational aids, etc, (Annexes 3 and 5).

In addition, the Parties undertook to provide adequate shore reception facilities for ship wastes, develop a surveillance system to detect oil spills, and to develop and implement an international contingency plan which would provide a coordinated response for the control and clean-up of spills of oil or other hazardous materials.

VESSEL WASTE REGULATIONS (Annex 4)

In the *United States*, the following recent actions have taken place with respect to development of regulations to control pollution from vessel wastes:

(a) The U.S. Coast Guard published regulations for the certification of Marine Sanitation Devices on January 30, 1975.

(b) The U.S. EPA published regulations regarding the performance of Marine Sanitation Devices on January 29, 1976.

(c) The U.S. EPA has acted upon various state requests to prohibit discharge to waters within their jurisdiction pursuant to Section 312(f)(3) and 312(f)(4) of PL 92-500. The State of Michigan has been granted such a request under 312(f)(3) which includes all Michigan waters of the Great Lakes and connecting channels. The State of Wisconsin has been granted similar authority for Lake Michigan, including Green Bay. Minnesota and Wisconsin have been denied their initial applications for Lake Superior.

Until vessel waste discharges are prohibited for all United States waters of the Great Lakes under the exception provisions of PL 92-500, a serious incompatability will exist with regard to vessel waste discharge regulations in the United States portion of the Great Lakes.

In *Canada,* proposed vessel waste regulations have been distributed for review. These regulations, applicable only to commercial vessels, allow either complete containment or the discharge of adequately treated sewage. Ontario, through an agreement with the federal government, continues to enforce "no discharge" requirements for pleasure craft in all Ontario waters.

In support of regulation development in Canada, the following studies have been carried out by Environment Canada on matters related to sewage wastes from shipping activities and their environmental impact:

(1) An inventory of Canadian commercial ships operating in the Great Lakes region to determine the extent to which vessel waste discharges are controlled.

(2) A study on waste volumes discharged by Canadian vessels operating on the Great Lakes.

(3) An inventory of shore-side reception facilities for ship wastes in Canadian Great Lakes ports with cost estimates.

(4) Design guidelines for shipboard sewage holding tanks.

(5) Design guidelines for shore-side sewage holding tanks.

(6) An assessment of currently available odour control chemicals for use in ships' sewage holding tanks.

U.S. and Canadian Coast Guard officials met in January 1976 to discuss the implications of states enforcing no discharge requirements under the exception provisions of PL 92-500 and the resulting incompatability between the U.S. and Canadian regulations. Although the regulations are considered to be compatible with respect to meeting the objectives of the Agreement, Canadian officials are seeking to have the proposed Canadian requirements recognized in the United States portions of the Basin.

The majority of the Board disagrees with the above approaches and the efforts to allow discharge of treated wastes. While the regulations may be compatible with respect to meeting the objectives of the Agreement they are not mutually compatible because of the different requirements imposed upon the operator of a vessel. Furthermore, the majority of the Board, as it has in the past, believes that total containment of all vessel wastes for discharge at shore facilities is the only equitable method of disposal.

VESSEL DESIGN, CONSTRUCTION AND OPERATION (Article V, Annexes 3, 4, and 5)

A joint Canadian/U.S. Coast Guard Report on the progress achieved on control of pollution from shipping activities was completed in February 1976 following a two-day meeting of the two Agencies held in January. Their report is reproduced in its entirety in Appendix C. The document was intended to constitute a joint progress report to the IJC toward achievement of essentially all of the activities specified under Article V 1(e), and Annexes 3, 4, and 5 of the Agreement, which deal with pollution from shipping activities.

While the two Coast Guards have, during the years, developed programs with respect to vessel design, construction and operation, control of shipboard wastes, improvements in navigational equipment and manning standards, there has not been appreciable activity specifically in the Great Lakes since the signing of the Water Quality Agreement.

The Water Quality Board reiterates its recommendations to the Commission regarding formation of a "Joint Activities Committee" under the Board. Further, the Board suggests that the IJC recommend to the Parties that they consider modifications to the Agreement, in their fifth year review, assigning specific responsibilities and deadlines for completion of actions under these Annexes.

SHORE RECEPTION FACILITIES (Article V, 1 (e) (iv))

In *Canada* in-depth studies have been completed with respect to the design, cost and placement of facilities for receiving and safe handling of shipboard wastes. The studies are now being reviewed and evaluated.

The *United States* has compiled a list of shore facilities for receipt of sewage and is compiling a similar list for oily-wastes. It is felt that there is an insufficient number of both types of reception facilities. As mentioned previously, development requirements, costs estimates, etc., are the responsibility of industry and state and local governments.

COORDINATED SYSTEM FOR SURVEILLANCE AND ENFORCEMENT (Article V, 1 (e) (v))

In July 1975, the Canadian and United States Coast Guards signed a Memorandum of Understanding Concerning Aerial Surveillance pursuant to Article V, 1 (e) (v) of the Agreement. This Memorandum of Understanding established a coordinated Canadian/U.S. aerial surveillance system of Great Lakes waters for abatement and control of pollution from shipping activities.

Under the program the waters of all five Great Lakes and connecting channels are patrolled, on a regular basis throughout the shipping season. Surveillance is carried out by aircraft of the Canadian or

U.S. Coast Guard which are manned by persons experienced in the identification of pollution from shipping activities.

Included in the Memorandum is a mechanism for the expedient notification of cognizant Canadian or U.S. enforcement officials. This system is compatible with the rapid alerting system established in the Joint Canada/U.S. Marine Pollution Contingency Plan.

Both the Canadian and U.S. Coast Guards have pre-designated specific officials, called Pollution Prevention Officers and Captains of the Ports, respectively, who are strategically located throughout the Great Lakes. These officials are charged with enforcement of pollution prevention regulations, investigation of and removal action on all pollution incidents reported from any source, and the initiation of legal action for contravention of pertinent legislation or regulations. A close liaison and exchange of information is maintained between the Canadian and U.S. Coast Guards in both investigative and enforcement activities.

The Memorandum has been formally presented to the International Joint Commission. Copies of applicable legislation and regulations have also been deposited with the Commission. While not included in the formal Memorandum, incidents of pollution observed by Canadian and U.S. Coast Guard surface vessels are also reported.

CONTINGENCY PLAN (Article V, 1 (h) and Annex 8)

The Joint Canada-United States Marine Pollution Contingency Plan, signed June 20, 1974 provides for a coordinated and integrated response to pollution incidents by federal, state, provincial and regional contingents of both countries. The Plan provides for pre-designated On-Scene-Commanders and Deputy On-Scene-Commanders to coordinate the response activities to spills and for a Joint Response Team to provide advice and assistance to the On-Scene-Commanders. It establishes alerting and notification procedures, command structure, post clean-up requirements and arrangements for assuming the responsibility for the cost of operations. The Plan replaced the 1971 Joint U.S./Canadian Oil and Hazardous Materials Pollution Contingency Plan for the Great Lakes Region.

Both the Canadian and U.S. Coast Guard believe that the Plan and the Joint Response Team have resulted in prompt, direct and decisive action in response to emergencies. The Canadian Coast Guard Emergency Office in the Central Region and the Marine Environmental Protection Branch in the office of Commander, Ninth U.S. Coast Guard District enjoy a close and harmonius relationship which has resulted not only in prompt invocation of the Plan but frequent reviews and recommendations for change, communication exercises and a frequently updated directory of cognizant personnel. The plan was invoked once in 1975 on the sinking of the freighter Fitzgerald on Lake Superior in November.

In addition to the maintenance of the Joint Contingency Plan, a special project called Operation Preparedness was developed to devise specific actions for high-risk areas in the Great Lakes System. These areas are those with fast-flowing waters and high shipping traffic density. The first set of field trials for testing new equipment and developing control techniques were held last summer in the Detroit/St. Clair River area. Results of these trials formed the basis of a specific action plan for that high-risk area. It is expected that similar exercises will also be conducted in the St. Lawrence River, St. Marys River and Niagara River/Welland areas.

10 FRAMEWORK FOR IMPLEMENTATION OF THE AGREEMENT

Under the Agreement the Parties undertook to implement, remedial programs and other measures which would achieve the water quality objectives of the Agreement. In addition, the International Joint Commission was assigned various powers, responsibilities and functions with respect to ensuring the effective implementation of the Agreement. The Agreement calls for a review of its effectiveness by the Governments during the fifth year, and the Board considers it timely and appropriate to express its general opinion in this regard.

Previous annual reports and the preceding chapters of this report have documented both progress made and delays encountered in meeting the objectives of the Agreement. In general, the Board considers that the very nature of the annual evaluations required by the Agreement have served to highlight strengths and weaknesses in each country's programs. The reporting procedures have focussed vital attention on the Great Lakes as an important national water resource of both countries, and the dialogue that it imposes has fostered a better mutual understanding of each country's problems and programs.

This chapter summarizes the major elements of each country's programs directly related to the Agreement and makes suggestions for improving the effectiveness of the Agreement.

SIMILARITIES AND DIFFERENCES OF REMEDIAL PROGRAMS

The environmental goals of both countries are compatible with the goals of the Agreement. The examination of major remedial programs provided in this report stresses the key common elements of both countries programs and their differences where these are considered significant.

Differences arise in such areas as: the degree of administrative discretion and program structuring, the financing or funding of pollution controls, the recognition given to the capacity of receiving waters to accept treated wastes, the timing of cost-effective abatement programs to achieve or maintain water quality conditions and the degree of public participation.

In spite of some differences in approach, the ultimate test of the success of remedial programs is their timely implementation and the results obtained in achieving the water quality objectives, particularly in areas with demonstrated water quality problems.

Intergovernmental Responsibilities

In the *United States*, the federal jurisdiction over interstate waters was expanded by PL 92-500 to include all waters of the United States. The law recognizes and preserves the primary responsibility of the states to prevent, reduce and eliminate pollution and calls for assumption of many responsibilities by state governments including permit programs, surveillance, enforcement and areawide planning. A significant degree of control over state programs is still exercised by U.S. EPA through the program grants and permit delegation.

In *Canada*, while land and water resources are a provincial responsibility, fisheries and international obligations are a federal responsibility. Duplication of effort in these shared responsibilities has been minimized by administrative agreements involving delegation of responsibility to the province e.g. fisheries matters.

Guidelines and Other Requirements

In the *United States*, the approach to implementing pollution control consists of a relatively structured, legal, regulatory enforcement system. This is particularly true for the definition of requirements for municipal sewage treatment and the establishment of effluent guidelines and limitations for industry. Guidelines have a legal status and many of them are being challenged in the courts. Guidelines are not enforceable per se, but are used in development of effluent limitations contained in NPDES permits which are enforceable and provide for strict civil and criminal penalties. Flexibility and exercise of administrative discretion are provided by the variance provisions of the regulations.

In *Canada*, existing legislation provides pollution control agencies with administrative discretion in implementation procedures. A guideline is commonly a statement by an agency to indicate those practices considered to be in compliance with the intent of particular legislation or regulations. A regulation or guideline indicates general minimum acceptable standards of practice used to develop effluent requirements. In determining effluent limitations, Ontario adjusts the minimum standards to satisfy local water quality conditions and issues a Certificate of Approval required by provincial legislation. Contravention of the conditions of a Certificate of Approval, an Order of the Ministry of the Environment, or the pollution prohibition provisions of Ontario legislation are enforceable in the Criminal Courts of the Province.

Financing or Funding of Pollution Control Works

In the *United States*, PL 92-500 provides for federal funds to be used to pay for 75 percent of the eligible costs of constructing municipal sewage treatment works. This funding is provided in three steps to cover planning, design, and actual construction of the facilities. Some states supplement federal funding with state grants.

Programs are also available to assist affected industrial dischargers with loans, industrial revenue bonds, accelerated depreciation, and investment tax credit and loan guarantees provided by the Small Business Administration. Some states allow property tax exemptions, sales and use tax exemptions and franchise and income tax deductions. These programs generally assist industry to finance capital costs of pollution control, which has sometimes resulted in a bias in favor of "end of pipe", capital intensive programs as oppposed to process change, or labor-intensive methods of control. However, some states do provide for encouragement of pollution control methods involving process modification.

In *Canada*, funding of municipal sewage treatment plants and associated sewage systems is normally shared by three levels of government - municipal, provincial, and federal - with repayment by the water user or resident.

Federal funding for municipal sewerage and sewage treatment programs is provided by the Central Mortgage and Housing Corporation. CMHC can provide long term loan assistance of up to 67 percent of the cost of eligible projects (treatment facilities; sanitary trunk sewers, storm trunk sewers that open up new residential areas; development of regional sewerage plans). CMHC may forgive payment by the borrower of 25 percent of the principal of the loan or grant where other funding is arranged. Where project costs are such that per capita costs would exceed $250, CMHC may make a grant of 50 percent of the eligible capital cost. As noted previously, the Agreement between Ontario and the CMHC will provide funding for sewage treatment plant and stormwater projects through 1980.

The Ontario Ministry of Environment may act as an agent for 30-year low interest rate self-liquidating financing, and the construction and operation of municipal sewage works projects. Since 1969, the province has supported two subsidy programs, namely: 1) capital grants up to 75 percent of the cost of Ministry-financed projects to the extent that annual homeowner costs exceed $130, and, 2) capital grants of 15 percent for provincial projects serving municipalities in areas where the province owns and operates the facilities in perpetuity. In 1974, the latter program was expanded to non-Ministry area projects in regional municipalities.

There are a number of programs available to assist industry with the financing of pollution abatement programs. The basic federal support program is the Accelerated Capital Cost Allowance program which allows a two-year depreciation for corporate income tax purposes of capital costs

for pollution control equipment. This program applies only to plants under construction before January 1, 1975, and terminates on December 31, 1976. New projects are expected to finance pollution control as a normal business expense. Companies willing to install commercial scale pollution control equipment that is innovative and previously untried are eligible for up to 50 percent support through the Demonstration of Pollution Abatement Technology program.

The intent of the Ontario Pollution Abatement Incentive Act of 1970 is to encourage the installation of pollution abatement equipment. Applications from industry for grants up to the equivalent of the provincial retail sales tax on equipment installed for purposes of pollution abatement are reviewed and recommendations for grants made to the Ministry of Consumer and Commercial Relations. In 1975, $2 million was paid, bringing to some $11 million the amount paid out to industry since the program started in 1970.

Pollution control equipment loans, administered by the Ontario Development Corporation, are intended to proved funds to existing companies unable to finance the purchase of this equipment from their own resources or from commercial lending institutions.

A Provincial accelerated capital cost-allowance program provides an allownace of 50% of the capital cost for equipment acquired by December 31, 1976.

DIALOGUE BETWEEN IJC AND GOVERNMENTS

IJC recommendations are meaningful only if they are presented to the Governments in a timely fashion and responded to by Governments in a timely fashion. Further, the Governments should indicate to the IJC their intentions respecting the implementation of recommendations.

Table 16 presents a chronology of dates on which Commission reports were released. The Canadian and United States responses to IJC's 1973 Annual Report did not materialize until June and October of 1975 respectively.

TABLE 16
PUBLIC RELEASE DATES OF REPORTS

Report	WQB Reports to IJC	IJC Reports to Governments	Governments' Response to IJC
First Annual Report (1972)	April 1973	September 1973	None
Second Annual Report (1973)	April 1974	September 1974	Canadian - June 1975 U.S. - October 1975
Third Annual Report (1974)	July 1975	March 1976	

Government responses should be regularly scheduled events, well coordinated by the U.S. Department of State and the Canadian Department of External Affairs. The importance of a timely and complete review is apparent since it can take up to two years before recommendations concerning financial requirements are reflected in federal budgets. In the United States the State Department should seek comments from federal agencies, and state governments when preparing responses.

Suggested Actions to Further Improve the Effectiveness of the Agreement

In order to improve dialogue between the IJC and Governments, the following suggestions are offered:

(1) Presentation of the IJC Annual Report should occur no later than 3 months after the formal receipt of the Annual Reports of the Water Quality Board, the Research Advisory Board and the Reference Groups.

(2) The Governments should respond to recommendations contained in the IJC Report, no later than 3 months after receipt of those recommendations. The government responses should include specific commitments to address administrative and legislative needs, if required, to implement the recommendations.

(3) The Commission should seek to maintain dialogue with the legislative and administrative branches of the governments respecting its recommendations. The pending amendments of PL 92-500 offer the Commission an unique and timely opportunity to re-emphasize to the U.S. Congress the importance of the Great Lakes as a valuable resource.

A conference of the Great Lakes Governors and Premier in 1970 has often been credited with providing an added impetus to the signing of the Great Lakes Water Quality Agreement in 1972. A follow-up session of this conference hosted by the Commission could reinforce and improve cooperation between governments.

(4) In order to better fulfill its obligations under the Agreement, the U,S. Government should seek means of sharing these obligations with the states. An example would be implementation of the extensive surveillance objectives under the Agreement.

In the next chapters the Board proposes new and revised water quality objectives and an "International Surveillance Program for the Great Lakes". Adoption of these by the Commission and the Parties is believed essential to the continued development, improvement and future effectiveness of the Great Lakes Water Quality Agreement.

11 WATER QUALITY OBJECTIVES

Water quality objectives provide one of the basic program elements of the Great Lakes Water Quality Agreement. The Parties have agreed that the means to improved water quality in the Great Lakes is through the adoption of common objectives and the development and implementation of cooperative programs and other measures to achieve those objectives. The Water Quality Board suggests that the specific water quality objectives serve as constraints on water and water related land use management plans in the Great Lakes Basin.

Canada and Ontario have agreed that the specific water quality objectives of the Agreement shall be the minimal objectives to be used by them in establishing water quality standards or other regulatory requirements in respect to the boundary waters of the Great Lakes System. The states in the Great Lakes Basin generally adopt or incorporate the Agreement's specific water quality objectives in their federally approved state water quality standards for the boundary waters within their jurisdiction.

The Board, through its Water Quality Objectives Subcommittee, has been developing specific water quality objectives for a range of parameters, on a "scientifically defensible" basis. If not exceeded these objectives will protect the most sensitive beneficial use of the boundary waters in all places. However, it is recognized that there must be thorough public discussions on the social and economic implications, and desirability of attempting to secure and protect all the waters of the Great Lakes for the most sensitive beneficial use.

It is particularly important that, where required, amendments to the water quality objectives be made upon agreement of the Parties to provide the basis for future programs required to restore, protect or enhance the quality of the Great Lakes.

Public discussions should begin as soon as possible to provide the Parties with additional background information necessary to make sound decisions on whether or not to incorporate the new or revised specific water quality objectives in the Agreement.

The Board has considered all the specific water quality objectives developed by the Water Quality Objectives Subcommittee as detailed in the 1974 Appendix "A" to the Third Annual Report and the 1975 Appendix "A" to this Fourth Annual Report.

Table 17 presents a proposed reorganization of Annex 1 of the Agreement listing all the existing and proposed new or revised specific water quality objectives. The proposed new or revised objectives can be divided into two groups as specified in Tables 18 and 19. The Board recommends to the Commission that the objectives in Table 18 be submitted to the Parties with a recommendation for adoption at this time. It further recommends that the objectives in Table 19 be submitted to the Parties for intiial consideration. However, recommendation for adoption of the latter objectives should be delayed as the Board is reviewing them internally and will comment further with respect to their implications for surveillance and remedial programs.

Details of the rationale for each proposed objective are included in the 1974 and 1975 Appendices "A" and are referenced in Tables 18 and 19.

In addition to the proposed new or revised specific water quality objectives, the Board also reiterates its recommendations for changes in the wording of the Agreement (see pages 159-162, 1974 Annual Report) to clarify the ideas presented therein and reinforce the intent of the Agreement to "maintain or enhance" existing water quality where it is better than described by the objectives.

BIOLOGICAL VALUE ALLOCATION

A portion of the narrative preceding the recommended water quality objectives in last year's report emphasized the necessity for development of a mechanism to limit the biological value loss and other beneficial use losses associated with mixing zones and other areas of non-compliance in such a manner that the integrity of the waterbody or portion thereof is assured.

A limiting mechanism incorporating management objectives and levels of protection was proposed which included the following basic steps:

1) Agreement on the biological and other uses to be protected;

2) Identification of the important species;

3) Biological mapping of the waterbody to establish biotic zones of the important species;

4) Assignment of a numerical biological value to the zones on the basis of importance to ecosystem function;

5) Selection of a level of protection for the waterbody;

6) Calculation of biological value available for allocation;

7) Allocation to present dischargers and reservation for future discharges.

The Water Quality Board acknowledged the future potential of the biological value allocation mechanism and authorized further development by referral back to the Implementation Committee and to the Research Advisory Board. The Water Quality Board was particularly interested in the availability of the biological data base and costs associated with gathering the missing information, the potential impact on existing dischargers, and the institutional arrangements for implementation.

The Research Advisory Board's Standing Committee on Scientific Basis for Water Quality Criteria and the Water Quality Board's Water Quality Objectives Subcommittee concluded that the first obstacle to overcome enroute to acceptance and implementation of this mechanism is development of waterbody maps.

Last year almost total emphasis was on biological (zoogeographical) mapping, supported by chemical and physical mapping, to establish biotic zones of important species. Such a map, or series of maps on a seasonal basis, would immediately identify areas important to ecosystem maintenance and provide insight into availability of habitat which by its scarcity is limiting to management objectives. This approach to waterbody mapping was too narrow in that beneficial uses other than biological were not included.

A Task Force working with biological, chemical, physical and social scientists familiar with Lake Ontario concluded that environmental value mapping to provide a holistic view of the system on an ecologically-meaningful scale was a prerequisite to development of any mechanism or plan for waterbody management.

Candidate information for environmental value maps includes: physical----- seasonal temperatures, depths, prevailing currents, bottom types; chemical----- areas of non-compliance, including mixing zones; biological-----fish (spawning, nursery, migration, living), marshes important to aquatic mammals and waterfowl, waterfowl feeding and wintering areas, gull nesting islands, benthos distribution and quality, zooplankton, phytoplankton, *Cladophora*, macrophytes; cultural uses-----water intakes, wastewater discharge sites, public recreation areas and parks, harbors of refuge and launching sites, fishing areas (sport and commercial), dams and fishways and areas of aesthetic and historical value.

The uses which could be made of waterbody environmental value maps include: identification and quantification of biotic zones; assignment of value; provision of a basis for limitations to configuration and conditions within mixing zones and other areas of non-compliance; site

TABLE 17

ANNEX 1 - OF THE GREAT LAKES WATER QUALITY AGREEMENT

1. Specific Objectives

A. Chemical Characteristics

(1) Persistent Toxic Substances

(a) Organic

(i) Pesticides

Aldrin/Dieldrin (2)
Chlordane (2)
DDT and Metabolites (2)
Endrin (2)
Heptachlor (2)
Lindane (2)
Methoxychlor (2)
Toxaphene (2)

(ii) Other Compounds

Phthalic Acid Esters (2)
Polychlorinated Biphenyls (2)
Other Organic Contaminants (2)

(b) Inorganic

(i) Metals

Arsenic (2)
Cadmium (2)
Chromium (2)
Copper (3)
Iron (3)
Lead (2)
Mercury (2)
Nickel (3)
Selenium (2)
Zinc (2)

(ii) Others

Fluoride (2)
Total Dissolved Solids (1)

(2) Non-Persistent Toxic Substances

(a) Organic

(i) Pesticides

General Objective (2)
Diazinon (2)
Guthion (3)
Parathion (3)

(Continued)

(ii) Other Compounds

Cyanide (3)
Oil and Petrochemicals (2)
Unspecified Non-Persistent Toxic Substances and Complex Effluents (2)

(b) Inorganic

Ammonia (3)
Chlorine (3)
Hydrogen Sulfide(3)

(3) Other Substances

(a) Dissolved Oxygen (1)

(b) pH (2)

(c) Nutrients

(i) Phosphorus (1)

(d) Tainting Substances (2)

B. Physical Characteristics

(1) Settleable and Suspended Solids and Light Transmission (2)

(2) Temperature (3)

(3) Asbestos (2)

(4) Radioactivity (1)

C. Microbiological Characteristics (1)

2. Non-degradation (2)

3. Enhancement (2)

4. Sampling Data (1)

5. Mixing Zones (Guidelines for Designation) (2)

6. Localized Areas (1)

7. Amendment (1)

NOTE:

(1) Existing specific water quality objective for which no change is recommended at this time - See Annex 1 of the Agreement.

(2) New or revised specific water quality objective being recommended for adoption - See Table 18 at the end of this Chapter.

(3) Proposed new specific water quality objective under review - See Table 19 at the end of this Chapter.

selection; guidance in dredging, filling and spoil disposal; background for aerial photography overlays; display of surveillance information; an extension of coastal zone mapping to permit holistic planning; identification of candidate areas of habitat rehabilitation; research planning; pinpointing priority areas to protect in the event of contaminant spills; and as a general education tool and popular guide.

The Research Advisory Board approved a workshop on Environmental Value Mapping of the Great Lakes for November 1976. Biological/environmental value maps as management aids have been produced for the Thames River in England, the Danube River in Germany, and Puget Sound, Chesapeake Bay, Galveston Bay, and San Francisco Bay in the United States. CCIW, Environment Canada, NOAA and New York Sea Grant are involved with special purpose mapping. The workshop will provide IJC cooperator organizations with an awareness of ongoing environmental mapping efforts in the Great Lakes and elsewhere in the world. The workshop will be designed to answer such questions as: What is the purpose of these maps? Their cost to construct? Why were certain characteristics mapped? Why were others left out? How have these maps been used? How can they be used in Great Lakes management? Why were certain display techniques chosen? Alternative displays?

The workshop will also provide an assessment of what information is essential or non-essential to support biological value allocation and establish whether or not biological entities can be mapped in such a way that value becomes apparent. In addition, the availability of the necessary information and the adequacy of present knowledge of the ecosystem structure and function will be determined.

The Water Quality Board awaits the product of the workshop, for the Board feels it is necessary to have a waterbody value map to reach any defensible decision on waterbody management. The Board is considering promoting the development of waterbody value maps for each Great Lake as an interagency project coordinated by IJC as an accompaniment to any waterbody management scheme.

FUTURE DIRECTION OF EFFORTS

The Water Quality Objectives Subcommittee is continuing its review of the scientific literature for new knowledge on cause/effect relationships which can be used to refine the specific water quality objectives and to develop new water quality objectives.

For future submission, the Subcommittee will consider the parameters listed below, but may not necessarily write objectives for them. A more detailed description of these future submissions, may be found in the Water Quality Objectives Subcommittee's report, Appendix A.

CHEMICAL CHARACTERISTICS		PHYSICAL CHARACTERISTICS	BIOLOGICAL CHARACTERISTICS
Inorganic	*Organic*		
Manganese	Mirex	Asbestos	Micro-organisms
	Nitrilotriacetic Acid		
Phosphorus (elemental)	Organophosphates		Toxicity units
	Carbamates		Biological effects of intakes
	Phenols		
Barium			Chlorophyll-a
Boron	Rotenone		
Sulphate	Organo-tin compounds		
	Detergents - Surfactants		
	- Builders		
Aluminum			
Silver	Polynuclear Aromatic Hydrocarbons		
Vanadium			
Thallium	3-triifluoromethyl - 4 nitrophenol		
Super saturation of dissolved gases	Pulp mill effluent components		
Nutrients - Nitrate			
- Silicate			
- Phosphate			

TABLE 18

SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference	
		Year	Page
	PESTICIDES (PERSISTENT)		
NEW	*Aldrin/Dieldrin* *The sum of the concentrations of aldrin and dieldrin in water should not exceed the recommended quantification limit of 0.001 micrograms per litre. The sum of concentrations of aldrin and dieldrin in the edible portion of fish should not exceed 0.3 micrograms per gram for the protection of human consumers of fish.* Note: Based on U.S. Food and Drug Administration guidelines.	1974	55
NEW	*Chlordane* *The concentration of chlordane in water should not exceed 0.06 micrograms per litre for the protection of aquatic life.*	1974	59
NEW	*DDT and Metabolites* *The sum of the concentrations of DDT and its metabolites in water should not exceed the recommended quantification limit of 0.003 micrograms per litre. The sum of the concentration of DDT and its metabolites in whole fish (wet weight basis) should not exceed 1.0 micrograms per gram for the protection of fish consuming aquatic birds.*	1974	61
NEW	*Endrin* *The concentration of endrin in water should not exceed the recommended quantification limit of 0.002 micrograms per litre. The concentration of endrin in the edible portion of fish should not exceed 0.3 micrograms per gram for the protection of human consumers of fish.* Note: Based on U.S. Food and Drug Administration guidelines.	1974	64

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	PESTICIDES (Cont'd)		
NEW	*Heptachlor* *The sum of the concentrations of heptachlor and heptachlor epoxide in water should not exceed the recommended quantification limit of 0.001 micrograms per litre. The sum of the concentrations of heptachlor and heptachlor epoxide in edible portions of fish should not exceed 0.3 micrograms per gram for the protection of human consumers of fish.* Note: Based on U.S. Food and Drug Administration guidelines.	1974	67
NEW	*Lindane* *The concentration of lindane in water should not exceed 0.01 micrograms per litre for the protection of aquatic life. The concentration of lindane in edible portions of fish should not exceed 0.3 micrograms per gram for the protection of human consumers of fish.* Note: Based on U.S. Food and Drug Administration guidelines.	1974	70
NEW	*Methoxychlor* *The concentration of methoxychlor in water should not exceed 0.04 micrograms per litre for the protection of aquatic life.*	1974	76
NEW	*Toxaphene* *The concentration of toxaphene in water should not exceed 0.008 micrograms per litre for the protection of aquatic life.*	1974	73

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	OTHER TOXIC PERSISTENT COMPOUNDS		
NEW	*Phthalic Acid Esters* *The concentrations of dibutyl phthalate and di(2-ethylhexyl) phthalate in water should not exceed 4.0 micrograms per litre and 0.6 micrograms per litre, respectively, for the protection of aquatic life. Other phthalic acid esters should not exceed the recommended quantification limit of 0.2 micrograms per litre in waters for the protection of aquatic life.*	1974	41
NEW	*Polychlorinated Biphenyls (PCBs)* *The concentration of total polychlorinated biphenyls in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of fish consuming birds and animals.*	1974	47

Note:

The detection limit for PCBs in water samples is not low enough to permit setting a water quality objective for concentrations in water. Therefore the proposed objective is based on levels detectable in fish tissue. It is believed that water concentrations less than 0.001 micrograms per litre would be required to preclude significant bioaccumulation of PCBs.

The U.S. Food and Drug Administration has set an administrative guideline of 5 micrograms per gram of PCB as the maximum levels acceptable in the edible portion of fish for human consumption. The Canadian Department of National Health and Welfare has set a similar guideline at 2 micrograms per gram of PCB. The Board is recommending a more stringent objective for the Great Lakes to protect birds and animals whose main diet consist of fish from the lakes.

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	OTHER TOXIC PERSISTENT SUBSTANCES		
NEW	*Other Organic Contaminants* *For other organic contaminants, the levels of which are not specified but which can be demonstrated to be persistent and are likely to be toxic, it is recommended that the concentrations of such compounds in water or aquatic organisms be limited to the detection level as determined by the best scientific methodology available at the time.*	1974	32
	METALS		
NEW	*Arsenic* *Concentrations of total arsenic in an unfiltered water sample should not exceed 50 micrograms per litre to protect raw waters for public water supplies.*	1975	18
NEW	*Cadmium* *Concentrations of total cadmium in an unfiltered water sample should not exceed 0.2 micrograms per litre to protect aquatic life.*	1975	22
NEW	*Chromium* *Concentrations of total chromium in an unfiltered water sample should not exceed 50 micrograms per litre to protect raw waters for public water supplies.*	1975	33
NEW	*Lead* *Concentrations of total lead in an unfiltered water sample should not exceed 10 micrograms per litre in Lake Superior, 20 micrograms per litre in Lake Huron and 25 micrograms per litre in all remaining Great Lakes to protect aquatic life.*	1975	49

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	METALS (Cont'd)		
NEW	*Mercury* *Concentrations of total mercury in a filtered water sample should not exceed 0.2 micrograms per litre nor should the concentration of total mercury in whole fish exceed 0.5 micrograms per gram (wet weight basis) to protect aquatic life as well as fish-consuming birds.*	1975	55
NEW	*Selenium* *Concentrations of total selenium in an unfiltered water sample should not exceed 10 micrograms per litre to protect raw water for public water supplies.*	1975	66
NEW	*Zinc* *Concentrations of total zinc in an unfiltered water sample should not exceed 30 micrograms per litre to protect aquatic life.*	1975	77
	OTHER INORGANICS		
NEW	*Fluoride* *Concentrations of total fluoride in an unfiltered water sample should not exceed 1.2 milligrams per litre to protect raw waters for public water supplies.*	1975	84

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	PESTICIDES (NON-PERSISTENT)		
NEW	*General Objective* *Concentrations of unspecified, non-persistent pesticides should not exceed 0.05 of the median lethal concentration in a 96-hour test for any sensitive local species.*	1975	101
NEW	*Diazinon* *The concentration of Diazinon in an unfiltered water sample should not exceed 0.08 micrograms per litre.*	1975	103
	OTHER NON-PERSISTENT ORGANIC SUBSTANCES		
REVISED	*Oil and Petrochemicals* *Oil and petrochemicals should not be present in concentrations that:* *1) can be detected as visible film, sheen or discolouration on the surface;* *2) can be detected by odour;* *3) can cause tainting of fish or edible invertebrates;* *4) can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or deleterious to resident aquatic organisms.*	1974	143
EXISTING	Oil and Petrochemicals Oil, Petrochemicals and Immiscible Substances. Waters should be free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges in amounts sufficient to be unsightly or deleterious. Oil or petrochemicals should not be present in concentrations that: 1) can be detected as visible film, sheen or discolouration on the surface; 2) can be detected by odour; 3) can cause tainting of fish or edible invertebrates; 4) can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or deleterious to resident aquatic organisms.		

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

		Appendix "A" Rationale Reference Year	Page
	OTHER NON-PERSISTENT ORGANIC CONTAMINANTS (Cont'd)		
NEW	*Unspecified Non-Persistent Toxic Substances and Complex Effluents* *Unspecified non-persistent toxic substances and complex effluents of municipal, industrial or other origin should not be present in concentrations which exceed 0.05 of the median lethal concentration (96-hour LC50) for any sensitive local species to protect aquatic life.*	1974	152
	OTHER SUBSTANCES		
REVISED	*pH* *Values of pH should not be outside the range of 6.5 to 9.0, nor should discharges change the pH at the boundary of the designated mixing zone more than 0.5 units from the ambient.*	1974	191
EXISTING	pH Values should not be outside the range of 6.7 to 8.5.		
REVISED	*Tainting Substances* *1) Raw public water supply sources should be essentially free from objectionable taste and odour for aesthetic reasons.* *2) Substances entering the waters as a result of human activity that cause tainting of edible aquatic organisms should not be present in concentrations which will lower the acceptability of these organisms as determined by organoleptic tests.*	1974	196
EXISITNG	Taste and Odour Phenols and other objectionable taste and odour producing substances should be substantially absent.		

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

	Appendix "A" Rationale Reference Year	Page
PHYSICAL CHARACTERISTICS		
REVISED *Settleable and Suspended Solids and Light Transmission* *For the protection of aquatic life, waters should be free from substances attributable to municipal, industrial or other discharges resulting from activity that will settle to form putrescent or otherwise objectionable sludge deposits or that will alter the value of the Secchi disk depth by more than 10 percent.*	1974	163
EXISTING Settleable Suspended Materials Waters should be free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl.		
NEW *Asbestos* *Asbestos should be kept at the lowest practicable levels and in any event should be controlled to the extent necessary to prevent harmful effects on health.*	1974	159
BASIC CONCEPTS		
REVISED *Non-degradation* *Notwithstanding the adoption of specific water quality objectives, all reasonable and practicable measures shall be taken in accordance with paragraph 4 of Article III of the Agreement to maintain the levels of water quality existing at the date of entry into force of the Agreement in those areas of the boundary waters of the Great Lakes System where such water quality is better than that prescribed by the specific water quality objectives.*	1974	223

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

	Appendix "A" Rationale Reference Year	Page
BASIC CONCEPTS (Cont'd)		
EXISTING Non-degradation Notwithstanding the adoption of specific water quality objectives, all reasonable and practicable measures shall be taken in accordance with paragraph 4 of Article III of the Agreement to maintain the levels of water quality existing at the date of entry into force of the Agreement in these areas of the boundary waters of the Great Lakes System where such levels exceed the specific water quality objectives.		
NEW *Enhancement* *In areas designated by the appropriate jurisdiction as having outstanding natural resource value and which have water quality better than prescribed by the specific water quality objectives, that water quality should be maintained or enhanced.*	1974	223
REVISED *Mixing Zones* *The responsible regulatory agencies may designate restricted mixing zones in the vicinity of outfalls within which the specific water quality objectives shall not apply. Mixing zones shall not be considered a substitute for adequate treatment or control of discharges at their source.* *The following guidelines should be used in the designation of mixing zones.* *1. A mixing zone is an area, contiguous to a point source, where exceptions to water quality objectives and conditions otherwise applicable to the receiving waterbody may be granted.* *2. Specific water quality objectives and conditions applicable to the receiving waterbody should be met at the boundary of mixing zones.*	1974	235

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

	Appendix "A" Rationale Reference Year	Page
BASIC CONCEPTS (Cont'd)		

3. Limitations on mixing zones should be established by the responsible regulatory agency on a case-by-case basis, where "case" refers to both local considerations and the waterbody as a whole, or segment of the waterbody.

4. Mixing zones, by definition, represent a loss of value.

5. Many of the general water quality objectives should apply to discharge-related materials within mixing zones. The zones should be free of:

- *(a) objectionable deposits;*
- *(b) unsightly or deleterious amounts of flotsam, debris, oil, scum and other floating matter;*
- *(c) substances producing objectionable colour, odour, taste, or turbidity; and*
- *(d) substances and conditions or combinations thereof at levels which produce aquatic life in nuisance quantities that interfere with other uses.*

6. No conditions within the mixing zone should be permitted which are either (a) rapidly lethal to important aquatic life (conditions which result in sudden fish kills and mortality or organisms passing through the mixing zone); or (b) which cause irreversible responses which could result in detrimental post-exposure effects; or (c) which result in bioconcentration of toxic materials which are farmful to the organism or its consumers.

7. Concentrations of toxic materials at any point in the mixing zone where important species are physically capable of residing should not exceed the 24 to 96-hour LC50.

8. When designing conditions to protect specific organisms it is necessary to know that the organisms would normally inhabit the area within the mixing zone. Zones of passage should be assured either by location or design of conditions within mixing zones. Mixing zones should not form a barrier to migratory routes of aquatic species or interfere with biological communities or populations of important species, to a degree which is damaging to the ecosystem, or diminish other beneficial uses disproportionately.

TABLE 18
SPECIFIC WATER QUALITY OBJECTIVES RECOMMENDED FOR ADOPTION

	Appendix "A" Rationale Reference Year	Page
BASIC CONCEPTS (Cont'd)		
9. Mixing zones may overlap unless the combined effects exceed the conditions set forth in other guidelines.		
10. Municipal and other water supply intakes and recreational areas should not be in mixing zones as a general condition, but local knowledge of the effluent characteristics and the type of discharge associated with the zone could allow such a mixture of uses.		
11. Areas of extraordinary value may be designated off-limits for mixing zones.		
12. The size, shape and exact location of a mixing zone should be specified so that both the discharger and the regulatory agency know the bounds.		
13. Existing biological, chemical, physical and hydrological condtions should be known when considering location of a new mixing zone or limitations on an existing one.		
EXISTING		
Mixing Zones		
The responsible regulatory agencies may designate restricted mixing zones in the vicinity of outfalls within which the specific water quality objectives shall not apply. Mixing zones shall not be considered a substitute for adequate treatment or control of dischargers at their source.		

TABLE 19

PROPOSED NEW WATER QUALITY OBJECTIVES UNDER REVIEW

TABLE 19
PROPOSED NEW WATER QUALITY OBJECTIVES UNDER REVIEW

		Appendix "A" Rationale Reference Year	Page
	METALS		
NEW	*Copper* *Concentrations of total copper in an unfiltered water sample should not exceed 5 micrograms per litre to protect aquatic life.*	1975	37
REVISED	*Iron* *Concentrations of total iron in an unfiltered water sample should not exceed 300 micrograms per litre to protect aquatic life.*	1975	45
EXISTING	Iron Levels should not exceed 0.3 milligrams per litre.		
NEW	*Nickel* *Concentrations of total nickel in an unfiltered water sample should not exceed 25 micrograms per litre to protect aquatic life.*	1975	62
	PESTICIDES (NON-PERSISTENT)		
NEW	*Guthion* *Concentrations of Guthion in an unfiltered water sample should not exceed 0.005 micrograms per litre for the protection of aquatic life.*	1975	107
NEW	*Parathion* *Concentrations of Parathion in an unfiltered water sample should not exceed 0.008 micrograms per litre for the protection of aquatic life.*	1975	110

TABLE 19
PROPOSED NEW WATER QUALITY OBJECTIVES UNDER REVIEW

		Appendix "A" Rationale Reference Year	Page
	OTHER NON-PERSISTENT ORGANIC COMPOUNDS		
NEW	*Cyanide* *Concentrations of free cyanide in unfiltered water samples should not exceed 5 micrograms per litre for the protection of aquatic life.*	1975	95
	NON-PERSISTENT INORGANIC COMPOUNDS		
NEW	*Ammonia* *Concentrations of un-ionized ammonia (NH_3) should not exceed 0.020 milligrams per litre for the protection of aquatic life. Concentrations of total ammonia should not exceed 0.50 milligrams per litre for the protection of public water supplies.*	1974	117
NEW	*Chlorine* *Total residual chlorine, as measured by the amperometric (or equivalent) method, should not exceed:* *1. 0.002 milligrams per litre in order to protect trout, salmon, and sensitive fish food organisms.* *2. 0.01 milligrams per litre in order to protect warmwater fish and most fish food organisms.*	1974	129
NEW	*Hydrogen Sulfide* *Concentrations of undissociated hydrogen sulfide should not exceed 0.002 milligrams per litre, at any time, or place, to protect aquatic life.*	1974	137
	PHYSICAL CHARACTERISTICS		
REVISED	*Temperature* *1. Thermal additions to receiving waters or a designated segment thereof should be such that thermal stratification and subsequent turnover dates are not altered from those existing prior to addition of heat from artificial origin.*	1975	113

TABLE 19
PROPOSED NEW WATER QUALITY OBJECTIVES UNDER REVIEW

	Appendix "A" Rationale Reference Year	Page

PHYSICAL CHARACTERISTICS (Cont'd)

2. *Maximum Weekly Average Temperature*

This is the mathematical mean of multiple, equally spaced daily temperatures.

A. *For Growth*

The maximum weekly average temperature (MWAT) in the zone inhabited by the species at that time should not exceed one-third of the range between the optimum temperature (To) and the ultimate upper incipient lethal temperature (Tu) of the species, in order to maintain growth of aquatic organisms at levels necessary for sustaining actively growing and reproducing populations (Table 1 Appendix II of 1975 Appendix "A"). Thus,

$$MWAT = To + \frac{Tu - To}{3}$$

The optimum temperature is assumed to be for growth but other physiological optima may be used in the absence of growth data. The MWAT must be applied with adequate understanding of the normal seasonal distribution of the important species.

B. *For Reproduction*

The MWAT reporduction should not exceed those limits for normal spawning (Table 2 - Appendix II of 1975 Appendix "A"); in addition these objectives must protect gonad growth and gamete maturation, spawning migrations, spawning itself timing and synchrony with cyclic food sources, and normal patterns of gradual temperature changes throughout the year. The protection of reproductive activity must take into account normal months during which these processes occur in specific water bodies for which objectives are being developed.

C. *For Winter Survival (applicable at any place inhabitable by fish)*

The MWAT for fish survival during winter should not exceed the acclimation, or plume, temperature (minus a 2.0°C safety factor) that raises the lower lethal threshold

TABLE 19
PROPOSED NEW WATER QUALITY OBJECTIVES UNDER REVIEW

	Appendix "A" Rationale Reference Year	Page

PHYSICAL CHARACTERISTICS (Cont'd)

temperature above the normal ambient water temperature for that season. This temperature limit will apply in any area to which the fish have access and would include areas such as unscreened discharge channels. This objective is necessary to eliminate fish kills caused by rapid changes in temperature due to plant shutdown or movement of fish from a heated plume to ambient temperature.

3. *Short-term Exposure to Extreme Temperature*

A. *For The Season of Growth*
The temperature objective for (1) short-term exposure during the growth season is the 24-hr. median tolerance limit, minus 2°C, at an acclimation temperature approximating the MWAT for that month; and (2) short-term exposure during the spawning season is the upper temperature for successful incubation and hatching. These exposures should not be too lengthy or frequent or the species could be adversely affected. The length of time in minutes (t) that 50 percent of a population will survive temperatures above the incipient lethal temperature (T in °C) can be calculated from the following equation:

$$\log (t) = a + b (T)$$

where a and b are intercept and slope, respectively, which are characteristics of each acclimation temperature for each species (National Academy of Sciences, 1973).

B. *For the Season of Reproduction*
For the short-term maximum temperature for the season of reproduction should be based on the maximum incubation temperature for successful embryo survival. The maximum temperature for spawning is probably an acceptable alternative.

EXISTING

Temperature (Interim Objective)
There should be no change that would adversely affect any local or general use of these waters.

12 SURVEILLANCE AND MONITORING

The basic elements of an International Great Lakes Surveillance Program were presented in the 1974 Water Quality Board Report. This plan has since been refined and expanded to meet the goals of monitoring the quality of the boundary waters to ensure that the water quality objectives are being met and to provide information for decisions on altering remedial measures.

GOALS

The primary goal of the surveillance program is to provide the information required to identify water quality issues and to assess achievement of water quality objectives. The water quality objectives in this general context include not only those parameters with numerical limits but also the concept of non-degradation of water quality. A secondary goal is to provide the information needed to relate achievement or non-achievement of the objectives to a particular cause. These goals require the measurement of both water quality conditions in space and time and material loadings to the lakes system. The goals also require or imply a framework in which to analyze the data. The proposed surveillance program, therefore, includes all the elements or components necessary to obtain these general goals.

Concerns for water quality in the Great Lakes are related to uses which require a specific level of water quality and to uses which adversely affect the water quality. The Water Quality Board has stipulated that the boundary waters must be protected for the most sensitive use. The elements of environmental concern resolve into a series of technical issues which include:

1. Enrichment
2. Organic contaminants
3. Metal contaminants
4. Radioactivity
5. Suspended materials
6. Microbiology
7. Dissolved materials
8. Trash, flotsam, jetsam
9. Thermal inputs

DESIGN COMPONENTS

The surveillance program has been developed to address the above water quality issues and designed in detail on an operational basis. The program is segmented by "design components" which are implemented by operational units. The components include:

1. Tributary Loading.
2. Atmospheric Loading.
3. Near Shore and Problem Areas.
4. Water Intakes.
5. Whole Lake - Annual and Intensive.
6. Compliance Monitoring.
7. Connecting Channels.
8. Fish Contaminants.
9. Wildlife Contaminants.
10. Cladophora.
11. Radioactivity.
12. Special Studies.
13. Data Quality.
14. Data Management.
15. Agency Support of IJC Surveillance Subcommittee.
16. IJC Regional Office Support.

The objectives and rationale of each design component have been developed by lake basin. The design components are described more fully in Appendix B and presented in detail in a separate International Great Lakes surveillance design document. Considerable refinements have been made since last year's report which include more emphasis on the monitoring of biological components, data quality, data management, radiological surveillance, atmospheric loadings, sediments, and toxic and persistent chemicals in water, sediment and fish. Recommended sampling frequency for major tributaries has increased from 12 to 26 times per year to enable better estimates of loadings. A toxic contaminants program for fish has been designed which will provide information on current conditions. Further development is necessary to provide for an evaluation of trends. Supplemental research efforts are necessary to describe the pathways and fate of specific toxic substances, and levels of contaminants in each trophic level.

SCHEDULE

A monitoring schedule was prepared for the entire Great Lakes System which will optimize the available surveillance resources including ships and laboratories. The schedule will maintain a continuity and stable level of work for the agencies involved.

It is proposed that the open waters of the lakes be sampled on a nine year cycle. Lakes Michigan, Erie and Ontario will be sampled intensively for two years, consecutively during the cycle. Lakes Huron and Superior will be sampled for one year during the cycle. During the intensive years, the nearshore-problem areas will also be sampled intensively.

In addition to the intensive program, Lake Ontario and Lake Erie will be sampled annually for specific enrichment related parameters.

The problem areas, including the connecting channels will be sampled less intensively each year for specific issue parameters. Tributaries will be sampled in a continuing year-round program.

IMPLEMENTATION

The degree to which the proposed surveillance program is implemented obviously depends on the resources provided by the two Governments. It is unclear at this time exactly what new level of funding will be available or even if the existing funding, which is less than adequate, will be maintained.

Annual follow-up workshops sponsored by the Board's Surveillance Subcommittee are planned to review the funds which have been provided and determine if the programs detailed in the plan are being carried out. The IJC Regional Office will support the Surveillance Subcommittee by documenting and publishing the detailed surveillance plans, updating the plans, and documenting the results of the workshops.

Data Quality

The quality of data is the most important part of the surveillance program. If the Great Lakes System is to be assessed as a whole as well as by segment and if the surveillance work is to be divided between agencies, it is imperative that a coordinated data quality assurance program be implemented immediately. This task has been assigned to the Board's Data Quality Subcommittee.

Data Management

A coordinated data management program is also required as one of the cornerstones of the surveillance program. Such an effort has been initiated by the Data Quality Subcommittee and should be continued. In addition, a concerted effort must be made, particularly by the U.S. agencies, to combine historical data into one data system.

Data Analysis and Reporting

Beyond the traditional data analysis and interpretation provided by the individual jurisdictions, there is the need for a comprehensive understanding of the cause and effect relationships in the Great Lakes System. It is only through a thorough approach to "modelling" the lake processes that such an understanding can be obtained. The development, calibration and verification of such models is, a matter for research. One goal of the surveillance program must be to provide much of the routine data and information required for model calibration and verification.

RESOURCE REQUIREMENTS

Surveillance cost estimates are being prepared for each design component, by task within component, and by agency. These details will form the basis by which the plan will be implemented and refined.

13 FUTURE STRATEGIES

The Agreement has two basic goals: to repair past damage to the Great Lakes, and to protect against future pollution. The first major target, December 31, 1975, has provided a focus for initiation and completion of remedial programs. Further, programs presently being implemented have achieved a momentum which, if sustained, will assure completion. However, completion of these programs will not be sufficient to achieve the goals of the Agreement. In some cases, there may be total recovery while in others the process of degradation may merely have been slowed. Moreover, correction of pollution from land runoff and atmospheric fallout is in an early stage of development. Increased pollution related to population growth and industrial development will place an ever growing stress on the water and the lands drained by that water and may offset current gains being achieved through the remedial measures of the Agreement. Closer cooperation should be sought by the Governments to plan for such growth and development of the communities in the Great Lakes System. Planning for prevention of future environmental damage is a permanent obligation facing the Governments in terms of the Agreement as populations grow, resources are developed, and the use of water increases.

The Board notes that the responsibility for planning future use of the Great Lakes-St. Lawrence Drainage System has been accepted by the eleven governments and new legislation and policy initiatives have been taken to get at the root causes of the many problems affecting the quality of the boundary waters.

In each country, basin planning, areawide planning and facilities planning are in various stages of development.

In the *United States*, planning efforts are centered around requirements of PL 92-500, activities under the Coastal Zone Management Act, and the coordinative and planning functions of the Great Lakes Basin Commission under the Water Resources Planning Act. Areawide, basin, and facilities planning under PL 92-500 are state and local government oriented and have the achievement of state water quality standards as the primary goals. Activities under the Coastal Zone Management Act are also state and local government oriented programs aimed at balancing developmental and environmental interests in the coastal areas of the Great Lakes. Finally, activities of the Great Lakes Basin Commission centre around

the development of the Comprehensive Coordinated Joint Plan which will identify projects, programs and other measures related to water and associated land resources that would enhance the economic, environmental and social conditions in the United States part of the basin.

On the U.S. side, recent litigation on the funding and timing of planning under Section 208 of PL 92-500 have created new problems for the states in developing effective comprehensive waste treatment management plans within the conditions stipulated in the Act. Resolution of these problems may necessitate amending PL 92-500.

In *Canada*, the emphasis in planning considers needs in development areas across the country encompassing the major drainage basins, of which the Great Lakes-St. Lawrence drainage system is one. The requirements of the Ontario Planning and Development Act recognize the importance of promoting optimum economic, social and environmental conditions in the five planning regions of Ontario with provision made for the management of land and water resources as a significant component of development plans under the Act.

Large scale planning in Ontario affecting the future Great Lakes environment is proceeding in various areas of land and water use such as transportation, tourism and recreation, food lands and energy. Compliance with the goals of the Agreement is considered in the review by the province of development plans and local official plans. The development of drainage basin planning under the Water Resources Act and the provisions of the Environmental Assessment Act are important measures to ensure that public and private projects are kept in conformity with environmental planning policies of the Province.

Detailed description of the two countries' planning programs are contained in Appendix C, the Remedial Programs Subcommittee's chapter on Future Strategies.

To strengthen and increase the coordination of existing planning efforts outlined above the Board recommends that the concepts of non-degradation and enhancement contained in the water quality objectives of the Agreement be accepted as important aspects of policies for prevention of future pollution and embody them in developmental planning policies, legislation, plans or by-laws, to serve as explicit planning guides. That is, these measures must be translated into requirements for reduction of presently uncontrolled sources of phosphorus and other pollutants resulting from existing and new uses of land for urban and industrial development, food production and related energy supplies.

The public has a right to be informed and participate where possible in the planning of communities consistent with the goal of preventing further pollution of the Great Lakes environment. While legislation in some cases provides opportunities for public access to information the procedures involved are often complex and other avenues may exist to increase the public's information, influence and participation in this area. These opportunities should be clearly identified and supported by governments.

APPENDICES

The various Subcommittees of the Water Quality Board and its Implementation Committee have prepared annual reports. These are published as separate Appendices to this Fourth Annual Report of the Water Quality Board. The subcommittee reports provide the detailed information and data for the Board's report but represent the independent efforts and views of the subcommittees and consequently some of the conclusions or recommendations contained therein may not be reflected in this report.

A. REPORT OF THE WATER QUALITY OBJECTIVES SUBCOMMITTEE

The Water Quality Objectives Subcommittee presents the results of its work in the 1975 - 76 in its second annual report to the Water Quality Board. The Subcommittee perservered in its charge to develop and recommend specific water quality objectives for the waters of the Great Lakes to ensure against the loss of beneficial uses agreed to by the Parties to the 1972 Great Lakes Water Quality Agreement. This year's report follows the philosophical approach developed in the first annual report for the establishment and use of water quality objectives.

The report deals comprehensively with a number of metals and proposes an objective for each metal which, in the scientific judgement of the members of the subcommittee, will adequately protect the most sensitive defined use of the Great Lakes waters. In addition to the metals, specific objectives are proposed for cyanide, fluoride, guthion, diazinon, parathion, and temperature. The scientific information used by the subcommittee in developing each of the specific objectives recommended is included as a rationale section with the objective.

A status report is presented on the concept to limit effects on the biota from point source inputs to the lakes by the allocation of biological value loss in mixing zones.

B. REPORT OF THE SURVEILLANCE SUBCOMMITTEE

The 1975 Report of the Surveillance Subcommittee presents an assessment of the water quality of the Great Lakes and connecting channels. Special attention is focussed on "problem areas" where the Great Lakes Water Quality Agreement specific water quality objectives and/or jurisdictional water quality standards are not being met. Lake-wide concerns, such as contamination of fish and wildlife by toxic substances and total pollutant loadings, are described for each lake.

In the 1974 report, the Surveillance Subcommittee provided a detailed assessment of the water quality in the Lake Erie/Lake St. Clair System. This year's report describes the existing conditions and recent trends in the water quality of the Niagara River, Lake Ontario and the St. Lawrence River. Efforts to mathematically model phytoplankton growth to evaluate the effect of present and projected nutrient loadings on Lake Ontario, are reviewed.

The International Great Lakes Surveillance Program has been reviewed and has been further detailed.

A brief report on the activities of the newly formed Data Quality Subcommittee is included.

C. REPORT OF THE REMEDIAL PROGRAMS SUBCOMMITTEE

The report of the Remedial Programs Subcommittee deals primarily with the continuing audit of the efforts of both the United States and Canada to implement the program requirements of Article V of the Great Lakes Water Quality Agreement. In past years, emphasis has been placed on programs to construct adequate sewage treatment facilities and to abate industrial sources of pollution.

This 1975 report reflects a change in emphasis and orientation. The subcommittee believes that its inquiries, while maintaining an oversight of current remedial measures, should be more oriented toward the future. Consequently, this report contains further information about water and related land use planning. Future reports of the subcommittee are expected to include more substantive analyses of these planning processes as they relate to the Great Lakes environment.

Additionally, in assessing the effectiveness of programs, this report includes a more detailed analysis of "problem areas" in the Great Lakes, the sources, and the specific remedial measures being implemented. Future efforts will consist of refining and improving these assessments with the goal of providing the most accurate information on the adequacy of specific remedial measures.

An aspect of remedial programs that relates to the changes in emphasis mentioned above is the increased attention being given to the effects of other environmental factors on water quality namely, land drainage and atmospheric loadings. The effects of completed remedial measures for point sources may often be masked in a "problem area" due to the effects of non-point source pollution associated with land use. The report updates the status of programs dealing with land use pollution.

Finally, as an expression of its concerns regarding the effectiveness of the existing relationships between the IJC and the Governments, the subcommitee offers some suggestions to improve those relationships.

D. REPORT OF THE RADIOACTIVITY SUBCOMMITTEE

The first annual report of the Radioactivity Subcommittee describes the status of the proposed radioactivity objective and surveillance plans for determining compliance with the objective. The report also describes the extent of nuclear facilities in the Great Lakes Basin and the discharges of radionuclides from them. Detailed information and data available as of May 1974 regarding radioactivity in the boundary waters are also presented and reviewed.

Copies of the Appendices may be obtained from:

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GLOSSARY OF TECHNICAL TERMS & ABBREVIATIONS

a - year (annum)

anaerobic - able to live and grow where there is no air or free oxygen, as certain bacteria

anoxic - depleted of free oxygen; anaerobic

BAT - Best Available Technology

BATEA - Best Available Technology Economically Achievable

bioaccumulation - uptake and retention of environmental substances by an organism from its environment

bioassay - biological assay: a determination of the concentration or dose of a given material necessary to affect a test organism under stated conditions

biomass - the living weight of a plant or animal population, usually expressed on a unit area basis

BOD_5 - Biochemical or Biological Oxygen Demand - the amount of oxygen utilized by micro-organisms in 5 days at 20°C in stabilizing the organic matter present in a water or sewage sample

BPT - Best Practicable Technology currently available

BPCTCA - Best Practicable Control Technology Currently Available

°C - degrees Celsius

CCIW - Canada Centre for Inland Waters

CMHC - Central Mortgage and Housing Corporation

coliform bacteria - a group of bacteria normally inhabiting the intestines of animals including man

conservative pollutant - a pollutant that is relatively persistant and resistant to degradation, such as PCB and most chlorinated hydrocarbon insecticides

CRSD - Cleveland Regional Sewer District

^{137}Cs - cesium - 137; a radioactive isotope of the element cesium with an atomic weight of 137

d - day

DDT - dichloro - diphenyl - trichloro ethane

D.O. - dissolved oxygen

DOE - Department of the Environment (Canada)

dredge spoils - the material removed from the lake bottom during dredging operations

epilimnion - the characteristically well mixed surface waters in a thermally stratified body of water

eutrophic - abundant in nutrients and having high rates of productivity frequently resulting in oxygen depletion below the surface level

°F - degrees Fahrenheit

fecal coliform bacteria - bacteria of the coliform group of fecal origin (from intestines of warm-blooded animals) as opposed to coliforms from non-fecal sources

FY - fiscal year

g - gram

GLECS - Great Lakes Environmental Contaminants Survey (United States)

HCB - hexachloro benzene

HUD - Housing and Urban Development Administration (United States)

hypolimnion - the region of a body of water that extends from below the thermocline to the bottom of the lake; it is thus removed from much of the surface influence

ICRP - International Commission on Radiation Protection

IJC - International Joint Commission

kg - kilogram

km - kilometre

l - litre

lb - pound

LC50 - median lethal concentration - the concentration of substance that causes death to 50% of a population within a given time period

limnetic zone - the open-water region of a lake supporting plankton and fish as the principal plants and animals

m - metre

mesotrophic - having a nutrient load resulting in moderate productivity

methylation - combination with the methyl radical (CH_3)

mg - milligram

MGD - million gallons per day (U.S. gallon)

MGD IMP - million gallons per day (Imperial gallon)

millirem - one thousandth of a rem

ml - millilitre

MOE - Ontario Ministry of the Environment

MPN - Most Probable Number (of coliform organisms)

MWAT - maximum weekly average temperature

NOAA - National Oceanic and Atmospheric Administration (United States)

Non-conservative Pollutant - a pollutant that is quickly degraded and lacks persistence, such as most organophosphate insecticides

NPDES - National Pollutant Discharge Elimination System of permits under PL 92-500

nutrients - organic and inorganic chemicals necessary for the growth and reproduction of organisms

oligotrophic - having a small supply of nutrients, thus supporting little organic production and seldom if ever becoming depleted of oxygen

P - phosphorus

PAHs - polynuclear aromatic hydrocarbons

PCBs - polychlorinated biphenyls

pCi - picocurie - a measure of radioactivity equivalent to 3.70×10^{-2} atoms disintegrating per minute

pesticide - any substance used to kill plants, insects, algae, fungi and other organisms; includes herbicides, insecticides, algalcides, fungicides and other substances

PL 92-500 - the 1972 amendments to the United States Federal Water Pollution Control Act

plankton - plants (phytoplankton) and animals (zooplankton) usually microscopic, floating in aquatic systems such as rivers, ponds, lakes and seas

PLUARG - International Reference Group on Great Lakes Pollution from Land Use Activities (IJC)

ppb - parts per billion

ppm - parts per million

productivity - the rate of storage of organic matter in tissue by organisms including that used by the organisms in maintaining themselves

^{226}Ra - radium - 226; a radioactive isotope of the element radium with an atomic weight of 226

rem - roentgen equivalent man - the standard unit of radiation dose

s - second

sludge - a solid waste fraction precipitated by a water or wastewater treatment process

^{90}Sr - a radioactive isotope of the metal strontium with the atomic weight of 90

STP - sewage treatment plant

t - tonnes (metric tonnes)

TED_{50} - total equivalent radiological dose in rem integrated to fifty years, received by the ICRP reference man from a standard daily intake of 2.2 litres of water over a period of one year

thermocline - a layer in a thermally stratified body of water in which the temperature changes rapidly with depth relative to the remainder of the body

UF_6 - uranium fluoride

ULRG - International Reference Group on Upper Lakes Pollution (IJC)

USEPA - United States Environmental Protection Agency

USFDA - United States Food and Drug Administration

µ*g* - microgram